Sustainably financing Improved Water Mill Electrification projects in rural Nepal

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Photo: IWM-E channel construction

Source: Fanny Verkuijlen
Source photo title page: Vince Oonk

Executive summary

This paper examines the sustainability of financing Improved Water Mill Electrification (IWM-E) projects in rural Nepal. The IWM-E technology can generate up to 5kW of electricity and thereby enable people in Nepal to harvest a part of the large hydro-electric potential present in the country. To examine the current and potential sustainability of financing IWM-E projects, a stakeholder analysis, a systemic analysis and a contingent valuation are conducted. The first phase of IWM-E project implementation has showed that financing these projects is a challenge. The current financing model, financing the first phase of IWM-E project implementation, incorporates a 80% subsidy component and a 20% community equity component. The stakeholder analysis shows that this financial mix is unsustainable. The subsidy component is too large for subsidy providers to continue funding these projects. The systemic analysis has examined the systemic problems in incorporating a loan component in financing IWM-Es. This analysis has examined the IWM-E sector's ability to provide this alternative credit facility by analyzing the quality of seven sector functions.

The systemic analysis indicates that four IWM-E sector functions show systemic problems. These functions are knowledge dissemination, mobilizing capacity building and subsidy resources, market formation and creation of legitimacy for the investment. Entrepreneurial activities, knowledge development and a guidance of search within the sector show no systemic problems although several issues of attention have been raised. The contingent valuation, the last part of this study, has generated insight in the community willingness to pay for, and community willingness to invest in, the IWM-E technology. These two community contributions, combined with a local labor and resource contribution and a subsidy contribution, create insight in the potential sustainability of financing IWM-Es. This analysis shows that the community contribution in financing the upfront costs can significantly go up by incorporating an equity in cash and a loan financing component. The five communities researched all show that a funding gap remains and additional funding needs to be sought. The potential increase of community contributions can make financing IWM-Es more sustainable, but financing the technology still depends on a significant subsidy component.

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Photo: Guided tour of Khangsang

Source: Fanny Verkuijlen

Chapter 1 - Introduction

Renewable energy is prominent in current national energy policy goals in both developing and developed countries around the world. In developed countries, renewable energy serves as an energy source which can reduce carbon emissions. It also serves to strengthen a secure supply of energy which is currently based on finite fossil fuel resources (Mackay, 2008). Renewable energy struggles to compete with fossil fuel based energy sources due to the fact that, amongst other things, fossil fuel based sources are mostly subsidized. In many geographic locations, renewable energy sources are more expensive than fossil fuel based energy sources (Mackay, 2008). In developing countries, renewable energy serves as a cost-effective source of energy in remote, rural areas (Glemarec, 2012). Around the world, more than 1.4 billion people lack access to modern energy services (Nepal, 2012). Access to modern energy services, predominantly electricity, can provide multiple benefits to those that lack access. The advantages include rising productivity, better health and access to information technologies. These benefits can create more time for education and other activities beneficial to development (Nepal, 2012).

Electrification of rural areas in Nepal began more than four decades ago. In 2011, 61% of the Nepalese population still lacked access to electricity, although this significantly decreased in the last decade. From 2001 until 2011, access to electricity in Nepal has gone up from 15% to 39% (Mainali & Silveira, 2011). Mainali & Silveira (2011) and Nepal (2012) argue that access to electricity is an important factor in the economic development of rural areas. The low population density results in low load factors for energy options. Due to this, off-grid decentralized alternatives are cost effective and more realistic options for electricity access. Micro hydro and solar PV technologies are most prominent in rural Nepal (Pigaht & Robert, 2009, Mainali & Silveira, 2011). The commercial potential of hydro-electricity is argued to be 42,000 MW, but only 2% of this potential is utilized in Nepal (Surendra et al., 2011). Local involvement in financing, development and implementation is essential in creating access to electricity in the rural context. However, finding financial resources for these investments is a challenge for utilizing the vast hydro-electricity potential (Mainali & Silveira, 2011, CRT/N, 2014, Glemarec, 2012, Beck, 2013).

While official development aid is being cut around the globe, private investments in developmental projects in developing countries are increasing (Glemarec, 2012). Development organizations are increasingly exploring the potential of private sector involvement. To drive the development sector, innovative ways of financing are sought. Providing microfinance loans to bottom of the pyramid customers, for investments in renewable energy technologies, has proven to be a worthwhile investment (Glemarec, 2012, Beck, 2013). The global trend away from publicly funded development investment and into privately funded development investment has also reached Nepal. Microfinance is a mechanism by which privately funded development investment can be channeled to development projects and has been emergent in Nepal since 1956. The microfinance sector, however, has only been able to provide credit facility to a relatively small, less-poor and geographically accessible part of the rural population. Access to credit facility for the poorest communities living in remote hilly and mountainous areas, has not yet been provided by the microfinance sector (Dhakal, 2007). There are thousands of microfinance institutions (MFIs) in Nepal (NRB, 2012). Dhakal (2007) argues that the

microfinance sector has reached 37% of its potential market and has focused on the relatively accessible ''low hanging fruit'' clients thus far. Therefore, the hard to reach fractions of the Nepalese society remain to be included.

A project to utilize the hydro-electric potential and enable access to electricity for remote poor segments of Nepal is the improved water mill electrification project. The Centre for Rural Technology Nepal (CRT-N) alongside the Dutch development cooperation SNV and the German Development cooperation GIZ, have supported the realization of improved water mill electrification (IWM-E) projects. IWM-E projects are systems which can generate up to 5kW of electricity for rural communities near a sufficient water resource. Using a proof of the concept study which verifies the technical and economic feasibility of the IWM-Es, implementing organizations, SNV and CRT-N, selected four different sites to establish the technology (SNV, 2014). The IWM-E projects are watermills which are upgraded to generate electricity for the community's productive and consumptive use. However, access to credit facilities is a challenge (CRT/N, 2014). With plans to upscale the number of IWM-E projects, access to loan financing for rural communities is an important factor. SNV (2014) argues that the availability of financing options for the IWM-E projects is a ''major challenge''. Similarly, Mainali & Silveira (2011) argue that mobilizing financial resources for rural renewable electricity investments in Nepal is often complex. Rural electrification struggles to advance without involvement of private financing and public coordination. Identifying innovative means of financing is essential to progression in rural electrification and, ultimately, rural development in Nepal (Mainali & Silveira, 2011).

The potential for installing IWM-E projects in Nepal is vast and demand for this technology is significant (CRT/N et al., 2014). IWM-E projects can help achieve increased employment and income levels and can serve as a thrust for local economies. Low income households or poor communities often cannot afford the high upfront costs. Furthermore, the private sector lacks the incentive to invest in renewable energy technologies in the rural context (Glemarec, 2012, Dhakal, 2007, Mainali & SIlveira, 2011). Arguably, the small size of the projects make it difficult for credit providers to cover their costs and risks while managing to keep their interest rates at an affordable level. Insufficient knowledge within the financial sector and IWM-E communities in addition to a weak institutional context, are potential challenges in providing credit facility to IWM-E projects. Innovative models of financing may serve as a solution to the issue of hindered access to credit facility for IWM-E projects in the rural Nepalese context.

1.1 Research questions

This research project's objective is to analyze the challenges and possible solutions for providing credit facility to IWM-E projects. The research aims to realize this objective by answering the following question:

- To what extent can current and alternative financial mechanisms provide sustainable credit facility to IWM-E projects?

The research question has been divided into three sub-questions. The answers to these questions will, when amassed, provide an answer to the main question. These three questions are:

- To what extent is current credit facility to IWM-Es sustainable?

- Are sustainable alternative sources of credit facility existent in the IWM-E sector and what are the systemic problems in the use of these sources?
- To what extent can alternative structures of credit facility make credit facility for IWM-Es more sustainable?

1.2 Academic relevance

Several developing countries have founded innovative models of rural off-grid renewable energy financing. Innovative financial mechanisms targeting upfront costs include, the leasing of energy technologies from the vendor, MFI financing, donor driven revolving funds and credit from unconventional financial institutions (Lemaire, 2009, Pigaht & Robet, 2009, Rao et al., 2009). Thus far, academic research exploring the relevance and potential of these financial mechanisms has not been conducted for the rural off-grid renewable financing of Nepal. A lack of perceived importance of credit facility through loan financing for rural renewable energy must be understood as a threshold for progress of rural electrification. Insufficient credit facility through loan financing is also observed in funding rural hydro-electricity in Nepal (Mainali & Silveira, 2011). Lending from commercial and development banks for renewable energy against some form of collateral is the most used financial mechanism in Nepal. However, this model focusses on larger scale projects than IWM-Es (Mainali & Silveira, 2009). This research paper is scientifically relevant as it investigates the potential of alternative forms of financing rural off-grid renewable energy projects. It utilizes the IWM-E projects as a means to investigate this potential. This study will investigate the potential for making IWM-E financing less subsidy-driven. It will focus on sustainable financing by analyzing the potential community contribution to IWM-E financing. The potential of innovative ways of credit facility and the potential of increasing community equity investments is analyzed.

1.3 Structure

This research paper follows the common academic structuring of a scientific report. The next chapter, chapter 2, contains the theoretical framework of the report. It consists of theory on the Nepal off-grid-renewable energy financing mechanisms and the innovative financial mechanisms practiced in other developing countries which aim to tackle the main challenges of the Nepal off-grid renewable energy financing context. Chapter 3 presents the methodology of the report and incorporates a clear outline of the research methods employed and the reasons and arguments for choosing these methods. The analysis of the data collected in this study will be discussed in chapter 4. Quantitative and qualitative data are analyzed, the key hypotheses are tested, connections to theory are made and the sub questions are addressed. Chapter 5 concludes with answers to the main research question. The paper ends by providing policy recommendations.

Chapter 2 – Theoretical framework

This chapter presents relevant theory on credit facility for IWM-E projects in rural Nepal. The framework follows a hopper approach starting with a broad perspective and then presenting more IWM-E case specific theory. For understanding the broader context, the framework starts with presenting the broader literature with theory on other country experiences in financing rural electrification. Then, the framework presents theory on credit facility in Nepal. After this, the financial market structure of Nepal, the microfinance sector development and regulatory environment, the microfinance sector outreach, the microfinance delivery mechanisms and the experience within the financial sector with renewable energy financing are reviewed. Then, the subsidy provision of the Nepalese government is analyzed. The framework ends with the financial mix. This creates insight in the relative importance of credit facility in financing IWM-Es.

2.1 Credit facility for rural electrification in the developing world

Glemarec (2012) argues that rural electrification faces inter-connected institutional, behavioral, technical and financial barriers. Woerlen (2011) and Glemarec argue that there are four main groups of stakeholders involved in making a sustainable market for rural electrification which exert influence on the interconnected barriers. These stakeholders are the users of the technology (IWM-E communities in this research), the supply chain of the technology, policy makers and financiers. Scaling up rural electrification technologies requires all stakeholder groups to be involved. Financial guarantees, for example, are ineffective if there is no demand for the technology and no regulatory context in place. Glemarec (2012) argues that most studies emphasize technological and economic factors but downplay end-user and behavioral factors. These factors are important in scaling up rural electrification (Glemarec, 2012). Glemarec (2012) argues there are three factors which need to be worked on; Increasing affordability of renewable energy technologies, increasing access to financing for the poor and removing non-economic barriers. This study focusses on increasing access to financial services (credit facility) and analyzes the interconnected institutional, behavioral, technical and financial barriers in the access to financing factor.

In Glemarec's (2012) literature review he argues that the high upfront costs make credit facility necessary. Around the world, 2,7 Billion people lack access to financial services (UNDP, 2011). Glemarec (2012) argues that access to credit facility is a key enabler for scaling up rural electrification. He argues there are five credit delivery mechanisms which are effective in developing countries:

'' dealer/supplier credit-based sales; consumer credit through commercial banks; consumer credit through microfinance institutions (MFIs); fee-for-service models where the equipment remains the property of the service provider; and public sector-operated revolving fund credit schemes (Glemarec, 2012).''

Glemarec (2012) argues that the use of a certain credit delivery mechanism depends on the context in which it is used and the options available in that context. The subsection on financing delivery

mechanisms will elaborate on the financing delivery mechanisms in the rural Nepalese context and compare the Nepalese options with the options observed by Glemarec (2012).

2.2 Necessity for credit facility for rural electrification in Nepal

Mainali & Silveira (2011) have researched renewable energy financing in rural Nepal and argue:

''Funding remains a major challenge if electrification is to reach larger fractions of the rural poor.''

Mainali & Silveira (2011) explicitly mention that the low perceived importance of credit facility through loan financing must be understood as a threshold that needs to be addressed if the rural electrification of the rural population is to make significant progress. The high upfront costs of renewable energy technologies make credit facility necessary. Insufficient credit facility through loan financing is also a challenge in financing rural hydro-electricity in Nepal (Mainali & Silveira, 2011). The upfront cost of the IWM-E projects in the first four IWM-E projects is 1,18 million NPR (7692,31 euro) on average per IWM-E project (SNV, 2014). The upfront costs of the IWM-E device are argued to be a challenge (SNV, 2014). The loan component together with subsidy and community equity makes up the financial mix of the IWM-E device. The size of the loan component in the IWM-E financial mix falls in the market of the microfinance sector and, therefore, the theoretical framework is predominantly built around the micro finance literature. Subsidy and equity investments are also part of the financial mix and, thus, the theoretical framework elaborates on these components as well. The IWM-E case is unconventional in the sense that the investment and, consequently, the possible loan component is relatively large for an individual client. The average loan size of microfinance institution (MFIs) in rural Nepal is between 10.000 NPR and 20.000 NPR but the contribution of a loan to financing the IWM-E is aimed to be between 100.000 NPR and 400.000 NPR. Furthermore, there is hardly any experience within the MFI sector in investing in renewable energy and funds are mostly invested in agricultural practices (RMDC, 2009, Mainali & Silveira, 2011).

2.3 Financial market structure

In order to understand the possibilities for loan financing one must understand the structure of the financial sector and the challenges for financing in rural Nepal. There are currently 7 types of financial institutions in Nepal out of which 6 are registered at the Nepal Rastra Bank (NRB) which is the central bank of Nepal. There are 25 commercial banks (A.), 60 development banks (B), 78 finance companies (C), 13 micro finance development banks (MFDBs)(D), 16 registered savings and credit groups (SCGs) (E), 45 Financial intermediary NGO's (FINGOS) (E) and an unknown amount of unregistered savings and credit cooperatives (F) (NRB, 2008). MFDBs and SCGs and unregistered savings and credit cooperatives together are micro finance institutions (MFIs). Class A/D is being regulated by the NRB. Commercial banks and multiple government and donor funds, unlike other financial institutions in Nepal, are usually not directly involved in micro financing but provide wholesale lending to various MFIs (Haduk, 2011). The main providers of wholesale lending are the NRB operated Rural Self-Reliance Fund , the Rural Microfinance Development Centre , the Sana Kisan Bikas Bank and the commercial banks. They provide wholesale loans at an interest rate between 3%-8% depending on the urgency to provide these loans

(RMDC, 2009). Wholesale lending in practice means capitalizing local financial institutions enabling them to provide financial services in the local context.

2.4 Microfinance regulatory environment and sector development

Besides understanding the financial market structure, understanding the regulatory environment and the sector development is important in understanding the challenges for IWM-E loan financing. When compared to the surrounding countries, Nepal is ahead and has developed its regulatory context for MFI's with specific regulatory designations for MFI's. Besides these designations, the only policy the Nepalese government has adopted is the National Microfinance Policy in 2009. This policy includes objectives that make microfinance more reliable, prepare microfinance legislations and develop institutional arrangements (Hudak, 2011). The NRB has also adopted several regulations relevant for micro financing in the 1992/2006 period. These are the Cooperative societies act (1992), the financial intermediaries act (1998), the Nepal Rastra Bank Act (2002), the NRB directives for microfinance institutions (2003) and the Bank and financial institutions act (RMDC, 2009). SCGs, FINGOs and MFDBs, can set their own interest rates due to deregulation by the NRB in the above stated implemented regulations in the 1992/2006 period (RMDC, 2009). Another relevant regulation is the maximum that MFIs can lend out to individuals. Since 2006, MFIs can lend out a maximum of 60.000 NRP to individuals without physical collateral and a maximum of 150.000 NRP to individuals with physical collateral (RMDC, 2009). The NRB also adopted the expansion of microfinance outreach in its 2006/2010 strategic plan. Although developing institutional arrangements for microfinance is stated as an objective, the capacity of the NRB to regulate and supervise the microfinance sector is still lacking. As Hudak (2011) argues*, ''it is not enough to have a policy if there is not the capacity to support it''.* This leads to non-compliant behavior of actors in the market (Hudak, 2011). The Non-Bank Financial Institution Supervision Department of NRB is to regulate the MFIs but due to lack of capacity in the NRB but this department is yet to be created (RMDC, 2009).

It is argued by Hudak (2011) that, besides a weak regulatory environment, there is a problem of insufficient capital reserves at MFIs. To tackle the problem of insufficient capital, the NRB directed that at least 3% (growing to 5% in 2015) of outstanding loans of commercial banks have to be invested in development of deprived people under the Deprived Sector Lending Program. This policy is aimed to buffer the capital of MFIs. The commercial banks that do not meet this target face heavy financial penalties. This leads to wholesale loan interest rates dropping when the policy deadline is almost due. This policy has resulted in commercial banks predominantly providing wholesale loans to the bigger MFIs, while leaving smaller MFIs without sufficient capital to extend operations (Hudak, 2011). There are also problems of MFIs not investing these wholesale loans in loans, but investing it in other safe investment options. It is argued, however, that the Deprived Sector Lending Program is essential in ensuring enough relatively cheap capital reserves in MFIs (RMDC, 2009).

2.5 Outreach of the financial sector

The development of the sector and the regulations and policies have large aimed to create further financial inclusion of the population of Nepal by creating bigger outreach of the financial sector. Understanding the outreach of MFIs in Nepal is important in understanding the access of IWM-E

communities to financial services. Lack of reliable data and a general lack of academic research using primary data on the outreach of financial institutions make the understanding of outreach problematic. Dhakal (2010) argues that community based MFIs hardly report to regulatory authorities, the MFIs are geographically scattered all over Nepal and there is a lack of a proper information on the operation of these institutions. Due to the lack of data, estimating the outreach of MFIs is always an approximation and Dhakal's (2010) effort in estimating the MFI sector's outreach is used to provide insight in the outreach of MFIs.

The outreach of financial institutions providing microfinance to the below the poverty line Nepalese population is 5.23% (Hudak, 2011). Dhakal (2010) argues MFIs exist in all 75 districts of Nepal. All types of MFIs exist in the less geographically challenging Terai region and presence of MFIs diminishes in the hilly and mountainous regions. Small loan size, small savings base, high delivery costs, lack of economic activity, lack of linkages with the financial sector and a lack of access to regulation and supervision are determinants for the limited presence of MFIs in hilly and mountainous areas (Dhakal, 2010). SCGs are by far the most dominant actors in the hilly and mountainous regions and there are hardly any clusters or villages without SCGs. Dhakal (2010) uses market potential servicing (amount of potential clients serviced where all adult individuals count as a potential client) as outreach determinant and argues that only 21.2% of the market potential for providing loans has been served. The data is skewed and the Eastern, Central and Western region market potential servicing is 20,3%, 27,2% and 30,8% respectively while the Mid-Western and Far-Western regions market potential servicing is 11,7% and 5,7% respectively.

Domestic NGOs, International NGOs (INGOs), bilateral agencies and multilateral agencies are active to promote financial inclusion and outreach of MFIs in Nepal. Dhakal (2010) argues that the potential of SCGs promoted by these actors, such as the Poverty Alleviation Fund and other donor sponsored initiatives, are not used and most of the times forgotten. Dhakal (2010) also argues that the potential of the informal non-registered SCGs is also not used to its full potential for MFI outreach. The problem of financial exclusion is most prominent at small-entreprises and low-income population segments. There is a need to increase access to financial services in remote areas and a need to deepen access to financial services in accessible areas to enable development of these areas (Dhakal, 2010). Dhakal (2010) does not provide insight into the capacity of these SCGs to perform these functions in the inaccessible areas, nor does he create insight in the ability of people in these areas to take on loans for productive investments.

2.6 Financing delivery mechanisms

The outreach of the financial sector is elaborated upon, but this does not explain which options of providing credit facility are existent in Nepal. In order to assess the options in providing financial services to IWM-E communities, it is important to understand which options delivery mechanisms of financing can be applied. Besides conventional financing through MFIs, alternative ways of delivering financing exist. It is argued that individual lending from commercial, development banks and lending from MFIs is most practiced in Nepal when analyzing the formal sector. Within the off-grid renewable energy sector this has only been practiced for biogas thus far (Mainali & Silveira, 2011). Countries with mature microfinance markets should use the existing financial infrastructure and deploy micro credit schemes

for financing renewable energy technologies. The MFIs are, according to Glemarec (2012), most appropriate since they have unrivalled knowledge of, relations with, and access to low-income target groups. Glemarec (2012) argues that, combined with a subsidy, the MFI is theoretically able to provide loans for all but the most expensive renewable energy technologies. Literature on the Nepalese credit facility for IWM-E size projects argues the possible delivery mechanisms are: conventional commercial micro financing, donor driven micro financing, informal community based micro financing and alternative micro financing (Lemaire, 2009, Pigahts & Roberts, 2009, Rao et al, 2009).

2.6.1 Conventional commercial microfinance

The conventional delivery of microfinance uses the commercial MFIs to provide credit facility but occasionally development banks provide these services as well. The push for liberalization by the NRB has led to a call for sustainable MFIs. A sustainable MFI, from a banker's perspective, is an MFI in which the operating income covers the operating costs, can obtain capital funds from the wholesale lending institutions and can mobilize local resources (Acharya & Acharya, 2006). These MFIs provide their clients with financial services at market prices. It is argued that this delivery mechanism is, after informal community based micro financing, most used in Nepal (Mainali & Silveira, 2011, Hatlebakk, 2000).

2.6.2 Donor driven microfinance

There is a wide range of donor driven microfinance in operation in Nepal. As mentioned earlier, NGOs, INGOs, bilateral agencies and multilateral agencies are promoting financial inclusion by targeting MFI outreach (Dhakal, 2010). Relevant for IWM-E financing, there have been two efforts by donors to create a model for creating credit facility for IWM-Es which are highlighted in this subsection. Other donor driven microfinance programs, however, are also active in Nepal. The two mechanisms are the Asian Development Bank (ADB) funded Social Merchant Banking Model (SMBM) and the multiple-donor funded Central Renewable Energy Fund (CREF) (AEPC, 2013, ADB, 2010). The main goal of these mechanisms is to provide credit facility at favorable, below market rate, prices to IWM-Es in the SMBM mechanism and renewable energy technologies in general in the CREF mechanism.

In 2008, the Nepalese government requested the ADB, in cooperation with the Alternative Energy Promotion Centre (AEPC), to develop a financing mechanism which was to provide credit facility to the Improved Water Mill program. As argued by the ADB, the aim of this program was; *''helping poor households gain access to local financing, technology, and know-how to enable financially viable but non-bankable projects to become* bankable'' (ADB, 2010). This model, however, has never been realized. The second relevant financing mechanism, CREF, is currently under construction and it is based upon revolving fund component. It aims to provide credit facility to renewable energy projects in Nepal (AEPC, 2013). They both use a revolving fund which is a fund that supplies credit to target populations. The repayment of these target populations recapitalizes the revolving fund enabling it to provide credit to other projects.

2.6.3 Informal community based microfinance

Informal moneylending is a common practice in Nepal (Hatlebakk, 2000). Individuals in the community, so called ''moneylenders, provide the community with financial services. As Hatlebakk (2000) argues, the high interest rate in this moneylending is an obstacle for rural development. Poor farmers get

involved in a vicious circle of debt with taking up a loan each year for consumptive purposes. The interest rates in these loans are said to be up to 50% per annum (Hatlebakk, 2000). This moneylending leads to an uneven distribution of wealth in the villages and leads to famers being unable to make productive investments (Hatlebakk, 2000). Hatlebakk (2000) argues that there is an increasing involvement of formal financial institutions competing with the moneylenders which is beneficial for rural development. Collateral and other formal requirements by formal financial institutions, however, are claimed to push beneficiaries to moneylenders, effectively leaving them with no choice than to use the moneylender services (Bhatta, 2002).

2.6.4 Alternative finance

There are multiple alternatives to commercial, donor driven and informal community based finance delivery mechanisms. Inaccessibility due to the geographical characteristics of hilly and mountainous areas, combined with poverty, are important obstacles for economic development and financial inclusion in Nepal. Therefore, the alternatives incorporated in this theoretical framework are alternatives that target these obstacles. Vendor financing is a form of delivering financial services using the actor who supplies the renewable energy technology. Mainali & Silveira (2011) argue that this model is mostly incorporating a fee-for-service model in which the supplier keeps ownership of the technology targeting the barrier of upfront costs. Vendor financing is practiced and successful in many African countries but is not commonly used in Nepal (Mainali & Silveira, 2011). Mobile banking using mobile phone technology is the other alternative targeting geographical obstacles prominent in the literature. Banstola (2007) argues that commercial banks in Nepal are making efforts to provide this service but have not penetrated the market significantly.

2.7 Financial sector experience in renewable energy financing

The study of Mainali & Silveira (2011) is the only study that has generated insight in the financial sector experience with renewable energy financing in Nepal. In their survey of the financial sector including commercial banks, development banks, finance institutions and MFIs they have found that less than 1% of the loan portfolio is directed to renewable energy projects. The interest rates in these projects varied between 10% and 16% and government banks provided lower rates than MFIs. MFIs at the local level showed interest in being more involved in financing renewable energy and commercial banks were least interested due to the high investment risks in these projects (Mainali & SIlveira, 2011). Only 4% of the above described 1% (0,04% of the loan portfolio) has been invested in the smallest hydro-electric projects analyzed in this study, IWM-E project investments are even smaller. Banks active in the sector were unsatisfied with the repayment rates in the projects they invested in and were rethinking their investment strategy. Mainali & Silveira (2011) observed a call of the financial sector to make the projects more bankable by minimizing risk, developing guarantee mechanisms and developing policy incentives to promote investment in renewable energy.

2.8 Government subsidies

Besides a possible loan component in the financial mix of the IWM-E, the financial mix also incorporates community equity and a government subsidy. The Ministry of Science, Technology and Environment has issued a new subsidy policy for renewable energy in 2013 (GON, 2013). This subsidy policy acknowledges

that past efforts in subsidizing renewable energy have resulted in accessible less-poor areas of the country benefiting from this policy. The people living in remote areas and poor households, however, are the most deprived group in terms of energy access (GON, 2013). Targeting this problem is done by providing subsidies, as shown in table 1, in three categories of village development committees (VDCs). The more accessible VDCs (category C) get lower subsidies and remote VDCs (category A) get higher subsidies. The overarching aim of the policy is to provide approximately 40% subsidy for a technology while the community has to take on a loan (40%) and provide community equity (20%). There is a maximum transportation subsidy of 90.000, 80,000 and 70,000 for Category A, B and C VDCs respectively (GON, 2013).

Table 1: IWM-E Subsidy policy 2013

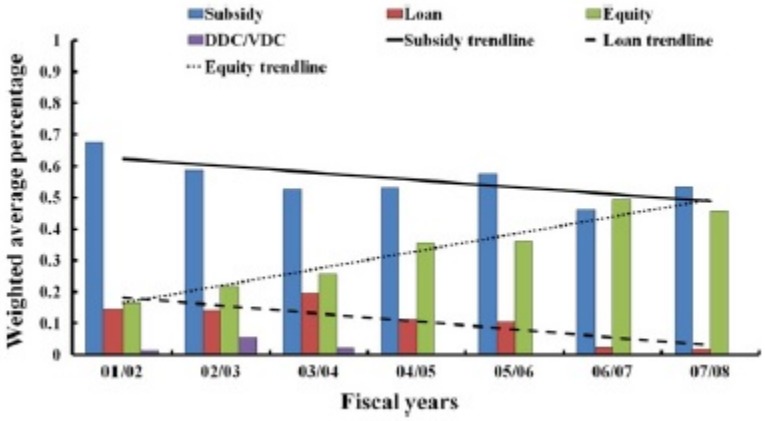
	Category A VDCs	Category B VDCs	Category C VDCs
Subsidy per household	8,000 NPR	7,000 NPR	6,000 NPR
Transportation subsidy per kW	20,000 NPR	10,000 NPR	5,000 NPR

Source: GON, 2013

2.9 Financial mix

The last part of the theoretical framework discusses the financial mix of IWM-Es. The financial mix of the IWM-E in the proof of the concept sites has thus far consisted of a donor subsidy of 80% and a community equity contribution of 20% (SNV, 2014). The loan component has not been part of the financial mix of IWM-E up till now. In the period of their study (2001-2008), Mainali & Silveira (2011) have found that equity has become more important in the total funding mix. Subsidies and loans decreased in the funding mix in relative terms in the 2001/2008 period in financing 4 kW to 98 kW hydro-electric projects. This is shown in figure 1. According to Mainali & Silveira (2011), a subsidy driven model has to be replaced by a model which reduces the subsidy amount, increasing the loan component and increasing the equity contribution. In this way, the donor driven or government driven subsidy funds can help to realize more IWM-E sites and, thus, more energy access in Nepal. The theoretical framework has elaborated on the loan component and subsidy component of the financial mix. Community equity is the last component of the financial mix. This can be provided either in labor and local materials (kind) or in cash (Glemarec, 2012, Mainali & Silveira, 2011). While it is positive that equity contributions are rising, the data in figure 1 shows that the lack of a significant loan component in the financial mix of hydro-electric projects serves as a threshold for progress of hydro-electricity in Nepal (Mainali & Silveira, 2011).

Figure 1: Financial mix trend-lines for hydro-electric projects in Nepal between 2001 and 2008.



Source: Mainali & Silveira, 2011

Chapter 3 - Methodology

The empirical testing of this research is based upon data collected by quantitative and qualitative methods. It is analyzed through a stakeholder analysis, a systemic analysis and a contingent valuation analysis. This methods chapter elaborates on the data collection, the stakeholder selection, the household sample, the stakeholder analysis, the contingent valuation analysis and the systemic analysis. It provides arguments for applying these methods and creates insights into the strengths and weaknesses of these methods.

3.1 Mixed methods

This research uses a mixed method approach combining both quantitative and qualitative techniques. The aim of the qualitative approach is to describe, interpret and explain the actions, experiences and outcomes in a certain context (Hart et al., 2009). Weaknesses of this technique are a potential lack of generalizability and a potential influence of the researchers bias. Its strength is that it is responsive to changes occurring in the study and can be useful in studying complex phenomena. The purpose of the quantitative approach, is to provide a quantitative description of attitudes, trends or opinions of a certain population by studying a sample of that population (Creswell, 2003). The main weakness of this technique is that the research might be too focused on hypothesis confirmation. The strengths are that it can lead to generalization and that it is less influenced by the researcher. This research aims to identify the challenges in credit facility for IWM-Es, explain its causes, explore potential solutions to these challenges and generate insight into the potential sustainability of financing IWM-Es. The need to incorporate both quantitative data collected from households, and qualitative data collected from stakeholders to reach the objective, drives the choice for the mixed method approach. The quantitative and qualitative data are collected concurrently. Insights from data collected through surveys, can guide the questions asked in the qualitative interviews (Creswell, 2003). Therefore, the research can confirm, corroborate and cross validate the findings generated in the study, offsetting many of the weaknesses of both methods. However, it can be difficult to compare the data generated from different sources and attention is given to this weakness.

3.1.1 Qualitative data collection and analysis

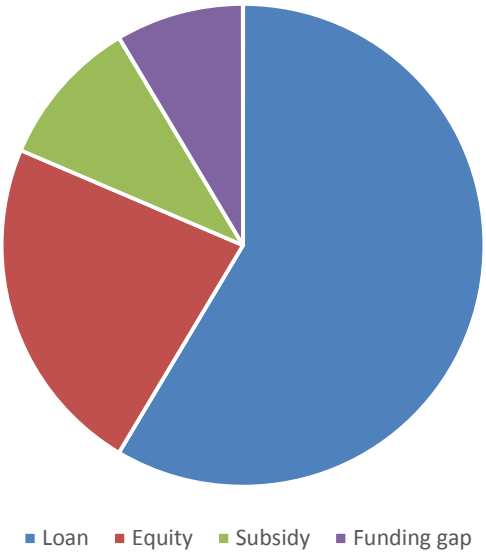
The qualitative data is collected by conducting semi-structured, in-depth interviews with relevant stakeholders. The interview is structured in order to obtain different answers to the same question. This enables analysis to be completed, focusing on the extent to which certain issues form a consensus. The interviews are not fully structured. This enables the researcher to ask follow up questions if answers are not clear, or if new insights need more in depth understanding. The development of credit facility is a complex procedure and the nuances of this process are not adequately captured with an overtly structured interview approach (Brugha & Varvasovszky, 2000). The interviews are conducted with the help of a topic list. This is a record of themes which help the researcher to adjust the order of questions in the interview. The topic list is added to appendix B. Questioning is open-ended. This enables the

interviewee to answer the question in the broadest and most informative way possible (Brugha & Varvasovszky, 2000).

3.1.2 Quantitative data collection and analysis

The quantitative data is collected using a household survey. This survey was produced in cooperation with Fanny Verkuijlen who was also researching the IWM-E case at the time of this research. The survey enables data collection pertaining to how sizeable the loan component can be. It incorporates a contingent valuation study, which collects information on the willingness to pay for (WTP) and willingness to invest (WTI) (besides paying monthly tariff for loan repayment) in financing IWM-Es. Contingent valuation is a method which collects data based on a survey to place monetary value on goods and services not traded in the market (Carson, 2000). In order to find out the potential paying for the IWM-E service in the community, the contingent valuation is performed. This data is used to explore to what extent the financial products provided for by the financial sector are affordable for the households and how much these households can invest from their equity. The WTP is linked to the different loan financing options which are found in the interviews with stakeholders in the credit facility chain. The WTI, combined with the loan component, and the government subsidy then enables insight in the remaining funding gap for financing the IWM-Es (Mainali & Silveira, 2011). Not all households in the different communities are surveyed. The average WTP (calculated into a maximum loan size by paying off a monthly tariff) and WTI collected for 6-7 households per community are aggregated for all households to gain insight into the potential size of the loan component and the community equity investment. This research conducted this analysis for the five communities visited separately to gain insight into different IWM-E sites. In this way, awareness into the importance of selection criteria in site selection is explored. Per community, the study then present a figure like figure 2 which will allow insight into the financial mix per IWM-E community.

Figure 2: Hypothetical financial mix IWM-E



3.2 Stakeholder selection for qualitative data collection

The stakeholder selection in this research is based upon the snowball technique. This allows the research to effectively develop an understanding of the complex issue involving human behavior in this study (Marshall, 1996). The first theoretical reason for choosing the snowball sampling technique lies in the fact that the sample population is small. An adequate stakeholder selection in this research is a selection that enables the researcher to adequately answer the research question (Marshall, 1996). The selection of new stakeholders that are to be interviewed has two constraints. The first is data saturation where new interviews with stakeholders do not provide new insights on the themes discussed in the interviews. The second constraint is a resource restriction in which the most limited resource is time available for the research. The snowball strategy in stakeholder selection is suitable because it yields a sample based on referrals of people involved in the issue of IWM-E financing who know stakeholders possessing knowledge of interest to this study. A potential weakness of the use of the snowball method is that insight is limited to the network in which stakeholders refer to other stakeholders. Besides analyzing the sector, the snowball technique enables the research to examine the natural interactions between stakeholders in the context of IWM-E financing in which a sustainable model for financing IWM-E's is to be found (Biernacki & Waldorf, 1981).

The stakeholders in IWM-E financing are broadly grouped in three categories: Kathmandu based stakeholders; district based stakeholders, and locally based stakeholders. The Kathmandu based stakeholders are: the Alternative Energy Promotion Centra (AEPC) which is a government institute, the Centre for Rural Technology Nepal (CRT-N) who are IWM-E project implementers, the Centre for

Microfinance (CMF) which is a knowledge institute, the Clean Energy Development Bank (CEDB) which is a development bank, the Nepal Rastra Bank (NRB) which is the central bank of Nepal and the Himalayan Bank which is a commercial bank. The district based stakeholders are Nilkantha Women saving and loan cooperative in Dhading Besi, the Ghatta Owners Association (GOA) in Dhading Besi, the GOA in Sindhuli besi, the Matri Bhumi development bank in Sindhuli Besi, the Country Development bank in Sindhuli Besi, the District Development Committee (DDC) in Sindhuli Besi and the Loknath Mishra Chimek Microfinance development bank in Sindhuli Besi. The locally based stakeholders are the Village development committee (VDC) in Kiranchowk, the IWM-E committee in Kiranchowk, the Local Partner Organization in Kiranchowk and Jogimara, the Shree Kiranchowk agriculture cooperative which provide financial services in the local context, the VDC in Jogimara, the IWM-E committee in Robang, the IWM-E comittiee in Foksinghtar and the IWM-E committee in Khangsang. A list of the stakeholders is added in appendix A.

3.3 Household sample for quantitative data collection

The communities surveyed are:

1. Kiranchowk community in Dhading district, 7 households
2. Jogimara community in Dhading district, 6 households
3. Foksinghtar community in Kavre district, 7 households
4. Ranichuri community in Sindhuli district, 7 households
5. Khangsang community in Sindhuli district, 7 households

In these communities, the households were selected with the help of the organization CRT-N organizing the field trips. Due to time and resource constraints, a random selection of households could not be carried out. The households were geographically too far apart to be selected randomly. Also, the sample per community is too small to form statistically sound generalizations. The communities Kiranchowk and Jogimara, were, at the time of data collection, building the IWM-E devices. The Foksinghtar community used a functioning IWM-E device. Ranichuri and Khangsang are considered technically feasible sites, but construction still needs to start in these communities.

3.3 Stakeholder analysis

Stakeholder analysis can be used as a tool for identifying opportunities to mobilize support of relevant stakeholders to improve credit facility in IWM-E projects in rural Nepal. Stakeholder analysis is a means of analyzing the interests of stakeholders in a certain context. The context of credit facility for IWM-E projects in rural Nepal involves participants of a diverse nature. The stakeholder analysis in this research analyses actors which are individuals, groups and organizations, relevant to credit facility. It is important to analyze and understand the source of peoples' behavior, in order to create effective policies and achieve improved credit facility in IWM-E projects. The information obtained from stakeholder analysis can be used to facilitate the implementation of decisions and guide organizational strategies in the IWM-E realization context. This credit facility is dynamic and complex, with several internal and external influences changing the situation. Therefore, this stakeholder analysis is complemented by a systemic policy framework analysis which will structure the data for the analysis of the second sub-question.

3.3.1 Systemic policy framework

Innovation scholars have used systemic policy instruments to research sustainability oriented innovation to bring about change. This research aims to research innovative change in credit facilities and thus is well suited to use this method. Generally, this line of research uses two different approaches to study innovation: structural and functional analysis. Structural analysis has been practiced to study and compare innovation systems. This type of analysis aims to structure the elements of an innovation system in a certain geographical scope (Wieczorek & Hekkert, 2012). Functional analysis is a framework that highlights processes which are beneficial to innovation systems.

Wieczorek & Hekkert(2012) have written a paper which combines structural and functional analysis into a systemic policy framework. This systemic policy framework method is utilized in this research report. According to Wieczorek & Hekkert (2012), structural and functional analyses have evolved separately, but are complementary. By combining structural and functional analysis, the systemic policy framework can identify systemic problems and suggest instruments to address these issues. This is done through both mapping functions in an innovation system, and evaluating the capacity of these functions, to enable sustainable credit facility to IWM-Es. By combining the mapping and evaluation of elements, you can combine the strengths of structural and functional analysis, while limiting the weaknesses of these frameworks (Wieczorek & Hekkert, 2012). Due to the use of the systemic policy framework, the interviewees are framed as the IWM-E sector innovation system that influence the creation and functioning of innovative financial solutions for IWM-Es. Their views on credit facility and the functions of IWM-E sector innovation system are used as inputs in the analysis of the functions of the innovation system.

Functional analysis aims to analyze the processes that are important in the functioning of innovation systems. The seven functions of the innovation system, used in this research project, are: (1) entrepreneurial activities, (2) knowledge development, (3) knowledge diffusion, (4) guidance of search, (5) market formation, (6) mobilization of resources and (7) creation of legitimacy (Johnson, 2001, Bergek, 2002, Hekkert 2007, Bergek et al. 2008). Wieczorek & Hekkert (2012) argue that the functions in an innovation system have to be divided up into four categories: actors, institutions, interactions and infrastructure. Each function is analyzed for these four categories to the extent that knowledge on this is present in the IWM-E sector. The stakeholders have been questioned on the quality of these functions. The quality of the functions give insight into the state of the IWM-E sector innovation system and provide a basis for the evaluation of these functions. In doing so, this research uses the systemic policy framework in a different way than Wieczorek & Hekkert (2012) who give quantitative scores to each function and base the evaluation on these numbers. This research follows a more qualitative approach and outlines the most important issues within each function. The approach of this research makes comparison of the relative importance of the systemic problems between the different functions difficult. The choice for this approach is based on the aim to create more in depth understanding of the systemic problems given that there is no academically researched insight in this thus far. Further research can create insight on the relative importance of the systemic problems within the functions.

Chapter 4 – Analysis and discussion

The analysis chapter is built around the three sub-questions guiding this research. The data is structured around the research questions. In answering the sub-questions, links to theory and a discussion on the strengths and weaknesses of the insights created by the data are discussed. The first part, current credit facility, gives answers to:

Q1: To what extent is current credit facility to IWM-Es sustainable?

This part of the analysis utilizes qualitative data and elaborates on the financial mix in IWM-E communities implemented under the proof of the concept phase. It elaborates on how communities were approached and analyzes the sustainability of the financial mix by conducting a stakeholder analysis. Links to the theory and strengths and weaknesses of data collection are discussed at the end of this sub-chapter. The second part, systemic problems in alternative credit facility, gives answers to:

Q2: Are sustainable alternative sources of credit facility existent in the IWM-E sector and what are the systemic problems in the use of these sources?

This part of the analysis utilizes qualitative data and uses the systemic policy framework by analyzing the performance of the seven functions in the IWM-E innovation system. The IWM-E sector is analyzed on the strengths and weaknesses in performing the seven functions to enable the incorporation of a loan component in the financial mix of the IWM-Es. It also discusses links to theory and data collection. The third part, sustainability of alternative credit facility, analyzes data and theory and gives an answers to:

Q3: To what extent can alternative structures of credit facility make credit facility more sustainable?

This third part analysis utilizes quantitative and quantitative data to create insight in the potential of alternative structures of credit facility for making the financial mix more sustainable. The structure of this chapter is built around the sub-questions and tests several hypotheses.

4.1 Current credit facility

This part of the analysis utilizes qualitative data and elaborates on the financial mix of IWM-Es which are already implemented, elaborates on how communities were approached and elaborates on the sustainability of this credit facility without a loan component. This is done by conducting a stakeholder analysis. Two hypotheses are tested and the analysis presents data relevant for answering:

To what extent is current credit facility to IWM-Es sustainable?

After analyzing the data and the hypotheses, the current credit facility chapter ends with giving an answer to the first sub-question. The answer to this sub-question is given based on data collected, considerations in data collection and theory.

4.1.1 Hypothesis 1

IWM-E project implementation approach is important in defining the sustainability of the financial mix

The current model of financing IWM-Es in the Foksinghtar and Kiranchowk and Jogimara implementation stage has been an 80/20 model. This means 80% of the funding has been provided by donors while 20% of the project was community contribution. The proof of the concept phase was aimed at proving the technology was technically and economically feasible. The strategy in this proof of the concept aimed for the 20% community contribution in either cash or kind. In implementing this stage, CRT-N (the implementing organization) approached the community Foksinghtar with this 80-20 model without investigating a bigger community contribution.

The incorporation of a loan component in the financial mix in was not discussed in implementing this phase. The 80/20 model approach of the communities is in part responsible for the lack of perceived possible higher tariffs observed in the interviews. As the IWM-E committee president in Kiranchowk answers when questioned on a possible raise of the tariff; ''I am only thinking about risks of the IWM-E being broken and paying for the maintenance''. The Jogimara IWM-E Committee and the Foksinghtar IWM-E committee focused on maintenance and operation only. Furthermore, according to CRT-N and Kiranchowk LPO, the communities want to contribute the lowest amount of money possible. The LPO in Kiranchowk argued, however, that it was already hard to convince the Kiranchowk community to contribute 20% of the project costs by equity in kind. All three villages have contributed their 20% equity share by providing labor and local materials to construct major parts of the IWM-E infrastructure.

4.1.2 Hypothesis 2

The 80/20 financing model is not sustainable

Due to the labor contribution, as argued by CRT-N, Kiranchowk LPO, Kiranchowk IWM-E Committee, Jogimara IWM-E Comittee, Foksinghtar IWM-E committee president, the communities have a strong sense of ownership of the IWM-E device contributing to the sustainable operations of the technology. However, it is argued by AEPC and GIZ-EnDev that such a large donor or subsidy contribution is not sustainable from a funding perspective since donor funding is a scarce resource. The IWM-E projects are dependant on GIZ-EnDev and AEPC funding. The fact that these organizations argue that the financing model is unsustainable weighs heavy on the sustainability of the financial model. AEPC, in cooperation with GIZ and SNV are pushing for increasing the community contribution in financing the IWM-E projects. CEDB and the Himalayan Bank argue, however, that the IWM-E technology in itself is economically feasible but not financially feasible. A subsidy component is necessary to make the technology financially feasible. The right balance between a subsidy component and the community contribution needs to be found in order to create a sustainable financial mix for IWM-Es (GIZ-EnDev, AEPC, CRT-N, Himalayan Bank, CEDB).

4.1.3 Sub-question 1

To what extent is current credit facility to IWM-Es sustainable?

It is argued by the stakeholders that the approach of the communities with the 80-20 model determined the lack of a bigger community contribution since the communities seek for the smallest contribution to the IWM-E project possible. The 80-20 model is argued by the stakeholders to not be sustainable since this model incorporates a large subsidy component. This is in line with the theory of Glemarec (2012) who argues that official development aid is being cut and private investments are increasing. A private

contribution is being sought in financing by exploring the potential of private sector involvement (Glemarec, 2012). It is argued by stakeholders that community involvement, in the form of the 20% equity contribution is important for sustainable operations and financing of the IWM-E projects. This is in line with the literature that argues that local involvement in financing, development and implementation is important in creating access to electricity in the rural context (Mainali & Silveira, 2011, Glemarec, 2012, Beck, 2013). It is important to mention that the stakeholders are mostly connected to GIZ, the organization for which this research has been produced. This has consequences for the perspective on credit facility. The sustainability of current IWM-E project financing is largely viewed from the perspective of the organizations that are involved in this current financing model. Other stakeholders, who argue that increased contributions of IWM-E communities are not sustainable, have not been found.

4.2 Systemic problems in alternative credit facility

The existence and systemic problems of alternative structures of credit facility incorporating a loan component are researched by analysing the IWM-E sector. The alternative credit facility is credit facility incorporating a loan component. The emphasis of this part lays on the provision of this loan component to the IWM-E communities. The ability of the IWM-E sector to develop and provide credit facility incorporating a loan component is analysed on seven IWM-E sector functions. The seven functions are: entrepreneurial activities, knowledge development, knowledge dissemination, market formation, resource mobilization and creation of legitimacy. The hypotheses tested are based on the seven functions and the issues raised within these functions are analyzed giving answers to the sub question:

Are sustainable alternative sources of credit facility existent in the IWM-E sector and what are the systemic problems in the use of these sources?

The chapter ends with answers to the stated sub-question. In answering this question, links to theory and strengths and weaknesses of the data collection and analysis are elaborated upon.

4.2.1 Hypothesis 3

Inadequate entrepreneurial activities are an obstacle to sustainable IWM-E credit facility

The function of entrepreneurial activities is the most discussed function in the IWM-E sector. Due to the wide range of issues raised in this function, the issues analyzed are diverse. The entrepreneurial activities are performed by the financial institutions in this analysis. To analyze this function both presence of entrepreneurs and the services they offer as well as the demands of IWM-E communities of these entrepreneurs are discussed. First, the presence of financial institutions, the types of financial institutions, their products and the availability of alternative products is analyzed. Then the requirements for financial products in the IWM-E communities are analyzed. For this, collateral, Interest, loan duration, capacity, local embeddedness and distance are discussed.

Presence of entrepreneurs

To analyze the presence of entrepreneurs for IWM-E communities, IWM-E communities where asked if they knew financial institutions in their local context. Regional financial institutions were asked if they would be willing to provide services to relatively remote communities. Locally, in Kiranchowk, the IWM-

E Committee knew about the local Agriculture cooperative and the Agriculture development bank providing loans. The Jogimara IWM-E Comittee knows about Focus Nepal, a donor driven financial service provider, and about banks. However, he did not know where to find these banks. In Foksinghtar, IWM-E committee president argued he knew banks but did not know how to get loans, he relied on informal community lending from nearby households. In Khangsang, the IWM owner relied on informal community loans and loans from the donor driven poverty alleviation fund. The IWM-E president in Ranichuri only knew a government poverty alleviation fund as potential loan provider. The two supra-local development banks in Sindhuli Besi, the regional city, were eager to get involved in financing IWM-E projects. The Nilkantha Women & saving Cooperative also wanted to get involved stating they observed clear benefits to women provided for by the IWM-E technology. The development banks as well as the Nilkantha Women & Saving cooperative argued that the IWM-E communities had to come to their financial institutions to get financial services.

Financial products

Different sorts of cooperatives, a MFDB, different development banks, FINGOs and commercial banks are involved in providing financial services in rural Nepal. Cooperatives are closest to remote IWM-E communities and the other actors are present in the supra-local context. The interest rates on loan products offered by cooperatives ranged between 15% and 18%. The loan size of the small local agriculture cooperative in Kiranchowk had a maximum of 25.000 NPR and required no group collateral for a loan up to 10.000 NPR. Bigger loans required physical collateral. The maximum loan size of the Nilkantha Women & saving Cooperative was 200.000 NPR and they work with group collateral, real estate collateral and savings as collateral. They both had a maximum of 2 years of repayment. Both cooperatives only lend out to individuals. The MFDB in Sindhuli Besi lends up to 60.000 NRP at 20% interest for a maximum of 18 months. The two development banks lend out money at an interest rate between 12% and 15%. Both require collateral in the form of real estate as regulated by their Kathmandu head offices. The small loan size between 100.000 and 500.000 NRP was no problem to them and even gave them more flexibility in how to invest this loan, without following strict company regulations. The maximum loan duration for both is 5 years. The Kathmandu based Himalayan bank did not want to directly provide loans to IWM-E projects since costs are projected to be too high and profits too low due to the small size of the projects.

All MFIs were guided in their practices by strict regulations in their own company. The main experience in all MFIs was investing in agricultural practices, with poultry as the most prominent investment. The MFDB in Sindhuli Besi stated; *''It needs to be a policy from the head office in Kathmandu before we finance IWM-Es''*. However, Shree Kiranchowk Agriculture Cooperative of the Kiranchowk agriculture cooperative argued that due to local demand, the cooperative started giving out loans for solar home system renewable energy technologies. The country development bank as well as the Chimek MFI bank and CMF argued that external guarantees for spreading risk could likely lead to experimentation in renewable energy investments.

Other financing delivery mechanisms

All interviewees were asked if they knew any alternative besides financing through MFIs operating in Nepal. None of the interviewees knew vendor financiers or other financial delivery mechanisms. The

GOA and CRT-N said their role as potential vendor financier had to be backed up by financial institutions to provide knowhow and regulatory changes to make it legal. CMF argued that it is best to use the MFI infrastructure in place. Vendor financing, according to CMF, is only an option if this infrastructure is not there. NRB Micro-Finance & Supervision argued that the NRB is encouraging vendor financing and branchless banking by creating policies and regulation supporting this activity. This, however, is at an early stage of development.

Collatoral, Interest and loan duration

A consensus in all IWM-E communities is that the loan component should, preferably, not incorporate physical collateral requirements. GOA Sindhuli and D.D.C. Sindhuli argued, however, that physical collateral would encourage loan repayment and advised to incorporate this in the credit facility. Cooperatives and MFDBs providing credit facility without physical collatoral requirements are preferred by IWM-E communities as well as GIZ-EnDev and CRT-N. The cooperatives and MFDBs loan duration serves as an obstacle to increasing the size of the loan (CMF, CRT-N, Chimek MFI Bank, GOA Sindhuli). This is because of IWM-E communities having a limited budget for repayment of the loan. The high interest rates in MFIs are also perceived as obstacles to getting a loan. The effect of interest rate and loan duration on the potential size of loans is further elaborated upon in the third part of the analysis.

Capacity and local embeddedness and distance

Capacity to manage a loan within the communities is an obstacle to loan financing and this view is widespread amongst the stakeholders (Kiranchowk IWM-E Committee , Kiranchowk LPO, GOA Dhading, CMF, Matribhumi Development Bank, Country Development Bank, D.D.C. Sindhuli, Chimek MFI Bank, GOA Sindhuli, CEDB, Himalayan Bank, AEPC, AEPC, NRB Micro-Finance & Supervision). CMF argues that capacity within MFIs is also a challenge. The MFIs are regularly unable to avoid duplication in lending (multiple MFIs lending to a certain individual). So called ''local knowledge'' is argued to be important in providing loans to rural communities since this enables the information required for assessing creditworthiness of the clients. The less-formal way of dealing with clients is connected to this local embeddedness of MFIs which are preferred by IWM-E communities. Trust in the MFI is a frequently stated requirement for lending from an MFI.

Distance in geographical terms is an obstacle for development banks as well as finance companies, MFDBs and commercial banks. It is a consensus that the distance increases transaction costs and makes credit facility expensive. A lengthy formal process in applying for a loan in combination with IWM-E communities not understanding these formal requirements are also obstacles for credit facility by development banks, finance companies, MFDBs and commercial banks. This distance also reduces the local knowledge and trust which is deemed important by local clients in the rural context. Presence of the financial institution in the local context enables more flexible lending practices which are beneficial to financial inclusion.

4.2.2 Hypothesis 4

Insufficient knowledge development and insufficient guidance of search is are obstacles to sustainable IWM-E credit facility

Credit facility within IWM-E implementation is a relatively new phenomenon. The actors driving the push for incorporating a bigger community contribution in the financial mix are GIZ, SNV, CRT-N and AEPC. This shared goal of these organizations is interpreted as a clear guidance of search in the IWM-E sector. The consensus is that the credit facility should be as affordable as possible. Efforts to develop knowledge and innovative ways to provide credit facility to IWM-Es have been undertaken by the IWM-E sector. These efforts have resulted in creating credit facility mechanisms based on revolving funds. These mechanisms are Social Merchant Banking and the CREF mechanism.

Social merchant banking

The AEPC in cooperation with the Asian Development Bank have tried to set up a credit facility mechanism between 2008 and 2011. This model incorporated a revolving fund providing local financial institutions with cheap capital enabling them to lend to IWM and IWM-E projects. A consensus is that the mechanism, in theory, was suited to provide adequate credit facility to IWM-Es. The mechanism proved to be working in India according to CEDB. In Nepal, this mechanism, however, has failed to come into existence. AEPC argued that there were issues between the AEPC and the Ministry of finance which resulted in the stalling of the project for multiple years. The Asian Development Banks then decided to quit the project. GOA Sindhuli, D.D.C. Sindhuli and CRT-N argue that it is important that a future mechanism succeeds since multiple communities were given false hopes by local partner organizations the organizations in close contact with IWM-E communities were blamed for it by these communities. The reasons for the failure of the social merchant banking model were not communicated to the GOA in Sindhuli which deals with local mill owners.

CREF mechanism

AEPC in cooperation CEDB, SNV, GIZ and CRT-N is currently developing a pilot phase incorporating loan financing in two IWM-E projects. This is to be implemented in the Ranichuri and Khangsang sites where this research has collected data from. The experiences are then incorporated in the CREF credit facility mechanism. Since CREF is still theory, it is hard to analyze the mechanism in a thorough way. The CREF mechanism is argued to provide cheap loans at 18% interest. The loan duration is not strict and is to be suited to the projects. There was also no clear limit to the amount to be lent to IWM-E communities and there is no maximum loan duration. The maximum loan duration for the IWM-E projects is argued to be the lifetime of the technology, which is projected to be 7 years. The mechanism uses a revolving fund to capitalize local financial institutions which have to disburse these funds to IWM-E projects (AEPC). The CREF also becomes responsible for government subsidy disbursements. Specific information on what kind of financial products CREF could offer, how these local MFIs are to be incorporated and if CREF incorporates guarantees for certain risks, could not be provided. In theory, CREF targets the challenges of slow bureaucratic subsidy disbursement, too short loan durations and too high interest rates. It is unclear to what extent local knowledge, trust, capacity development within MFIs, capacity development within communities and flexibility in providing credit facility are incorporated in the mechanism.

4.2.3 Hypothesis 5

Insufficient knowledge dissemination is an obstacle to sustainable IWM-E credit facility

The third IWM-E sector function analysed is the knowledge dissemination function. Knowledge on credit facility is being developed by the IWM-E sector. The question in this part is to what extent these knowledge developers disseminate this knowledge. The IWM-E sector incorporates a strong partnership between AEPC, GIZ and SNV. The CEDB is currently incorporated in this partnership and consulted on how to incorporate a loan component in the IWM-E financial mix. Other MFIs, such as cooperatives, MFDBs and stakeholders such as knowledge institutes are not involved in the development of the pilot stage for credit facility to IWM-Es. Knowledge institutes such as the CMF could assist in developing credit facility mechanisms. The knowledge on new ways of financing is not disseminated to the IWM-E sector as a whole. It is argued that the knowledge on incorporating a loan component is not developed enough to disseminate to the IWM-E sector.

The IWM-E technology is not well known in the financial institutions. Only one MFI, the Neelkantha Women Savings & Loan Cooperative, heard about the IWM-E technology. The other MFIs, Shree Kiranchowk Agriculture Cooperative Organization, Matribhumi Development Bank, Country Development Bank, Chimek MFI Bank and the commercial; Himalayan Bank Pvt. Ltd, did not know about IWM-Es specifically. A platform for knowledge dissemination amongst the local MFIs and other IWM-E sector stakeholders is missing. Existence of such a platform is deemed important when the number of IWM-E projects is scaled up.

4.2.4 Hypothesis 6

A lack of market formation is an obstacle to sustainable IWM-E credit facility

Additional value created by IWM-Es, efficient subsidy delivery, site selection criteria and a lack of experience in loan financing IWM-Es are the problems in market formation. The off-grid renewable energy market is argued to penetrate the rural population unevenly. Insights in the theoretical framework are confirmed in the stakeholder analysis as multiple interviewees argue that the easily accessible people have been served. Quantitative data is , however, not available for this. IWM-Es are argued to deliver more electricity than solar panels (which are dominant in rural Nepal) and to enable productive end use of electricity which leads to a bigger market (Giz-EnDev, AEPC). The IWM-E technology provides more kWs and enables households to run radios and TV's. The IWM-E devices, however, have not demonstrated to enable functioning productive end uses of electricity in the communities visited. This is argued to hold back market expansion. Besides this problem in market formation, the interviewees also agree on the observation that, for IWM-Es, inadequate loan financing and a cumbersome subsidy delivery system are holding back further market expansion. The technology, in part, is dependent on subsidy to become financially feasible (CEDB, AEPC, Himalayan Bank, CMF, CRT-N, Kiranchowk LPO, D.D.C. Sindhuli, Matribhumi Development Bank).

To get an IWM-E as a local community, the community has to apply at the local GOA or government offices. Out of the communities that applied, suitable communities are selected. Since the IWM-E technology implementation is subsidy dependent, it is dependent on site selection criteria of subsidy and donor funding providers. The AEPC, an (amongst other things) subsidy providing body of the government of Nepal, aims to increasingly finance the poorer less accessible segments of society. Incorporation of a loan component is, as argued by all financial institutions, more likely to be successful

in more accessible parts of rural Nepal. The aims of targeting the poorer, less accessible segments of society, in combination with incorporation of a significant loan component are argued to be contradictory. After experience is built, expansion of the IWM-E market could be an option (Himalayan Bank, CEDB, Chimek MFI Bank, Country Development Bank, Matribhumi Development Bank, CMF, Neelkantha Women Savings & Loan Cooperative, Shree Kiranchowk Agriculture Cooperative).

4.2.5 Hypothesis 7

Insufficient mobilization of resources is an obstacle to sustainable IWM-E credit facility

Closely related to the issues raised in the market formation function, are the issues raised in the fifth of seven IWM-E sector functions: mobilization of resources. According to stakeholders, there are three important resources that are mobilized; Capital resources in financial institutions, subsidy resources from the government and capacity building resources in IWM-E communities and financial institutions.

Capital mobilization

The capital reserves of MFIs are argued to have grown due to the deprived sector lending program issued by the NRB. When MFDBs and cooperatives were asked if there capital reserves were sufficient to provide IWM-Es with credit facilities, they did not give straightforward answers. Shree Kiranchowk Agriculture Cooperative, Matribhumi Development Bank, Country Development Bank, Chimek MFI Bank did not mention a lack of capital as a challenge. However, MFDBs and Cooperatives were not willing to lend above 500.000 due to insufficient capital reserves. NRB Micro-Finance & Supervision argues that the capital stock growth due to the deprived sector lending program is not enough and MFIs should more actively look for other capital. Neelkantha Women Savings & Loan Cooperative argued that direct additional capital provision by donors would make lending to IWM-Es easier and more affordable.

Capacity mobilization

CMF, CEDB and NRB Micro-Finance & Supervision argued that both MFIs and communities needed capacity building to provide IWM-Es with credit facility. Due to lack of experience with renewable energy financing in the sector, problems of loan duplication and weak corporate governance, the MFIs are argued to need capacity building. The visit to Khangsang, for example, showed clearly that the IWM owner was already heavily indebted. He argued that if the IWM-E would not be installed, he could not repay his loans. He showed no insight, however, in how he could profit from the IWM-E if he did not invest in the IWM-E himself. The other communities, however, did not show over-indebtedness. It is a consensus that IWM-E implementation needs to incorporate trainings on sustainable financial management.

Subsidy mobilization

A culture of subsidy dependence is argued to make rural communities unwilling to financially contribute to development projects (CMF). This culture is argued to distort the markets (CEDB). The government subsidy disbursement is argued to be cumbersome (CMF, CEDB, GIZ-EnDev, CRT-N, AEPC). CEDB argues that the total government subsidy provision should be more structured enabling more effective credit facility to IWM-Es. NRB Micro-Finance & Supervision argues that subsidy budgets are limited and are likely to decrease since government budgets are under pressure. AEPC, however, argues that subsidy budgets are stable and inflation is a bigger issue.

4.2.6 Hypothesis 8

Insufficient creation of legitimacy is an obstacle to sustainable IWM-E credit facility

The last IWM-E sector function analysed is the creation of legitimacy function. How Investment in the IWM-E technology is perceived is relevant in analyzing the legitimacy of the IWM-E technology credit facility. The creation of legitimacy is argued to be important for market expansion and resource mobilization. In general, renewable energy investments in Nepal, are argued to not be financially feasible without subsidies. The case of IWM-Es is also argued to only be financially feasible with a significant subsidy (CEDB, AEPC, NRB Micro-Finance & Supervision ,AEPC, Himalayan Bank, D.D.C. Sindhuli, Chimek MFI Bank, Country Development Bank, Matribhumi Development Bank, CMF). The IWM-E technology was unknown to all financial institutions except one, the Neelkantha Women Savings & Loan Cooperative. Neelkantha Women Savings & Loan Cooperative argued that the technology showed clear productivity benefits to women and her cooperative has willing to provide loans to IWM-E communities. Himalayan Bank argued that loans from Himalayan bank in renewable energy had proven to underperform and his bank was increasingly hesitant to provide loans to renewable energy in rural areas. In relation to this, it is argued that IWM-E credit facility mechanisms need to incorporate a risk sharing component. This component is necessary to make investing in the technology, and capitalizing local MFIs for these investments, more legitimate (CMF, NRB Micro-Finance & Supervision, AEPC).

4.2.7 Sub-question 2

Are sustainable alternative sources of credit facility existent in the IWM-E sector and what are the systemic problems in the use of these sources?

Different sources of credit facility are existent in the IWM-E sector. The entrepreneurial activities of these financial institutions are argued to be adequate. Locally embedded, cheap, physical-collateral-free loans, are preferred by IWM-E communities. Knowledge development and a shared goal of increasing community contributions is present in the IWM-E sector and has resulted in the creation of the CREF credit facility mechanism alongside with a planned experimentation with incorporating a loan component in two IWM-E projects. Knowledge dissemination, however, is argued to be insufficient in the IWM-E sector as all but two financial institutions did not know about IWM-E projects. Market formation faces systemic problems due to the fact that projects are subsidy driven and site selection criteria of financial institutions and implementers are contradicting. Mobilization of capacity building and subsidy resources is inadequate and forms an obstacle for IWM-E credit facility. The CREF credit mechanism, however, is argued to incorporate the mobilization of these resources. Investments in renewable energy technologies in general, and IWM-E technologies specifically are argued to be risky and illegitimate. A form of risk sharing between investors and other parties is argued to be important in sustainable IWM-E credit facility.

The observed systemic problems are in line with theory of Mainali & Silveria (2011) who argue that mobilizing financial resources for rural renewable electricity investments in complex. The financial barriers show interconnections with institutional, behavioral and technical barriers (Glemarec, 2012). End-user IWM-E community factors and behavioral factors are, besides economic and technological factors, present in the IWM-E sectors ability to provide credit facility (Glemarec, 2012). The risky

perception of IWM-E investments by stakeholders is a logical consequence of lack of experience in investing in these projects. Theory on a lack of experience within the financial sector in investing in hydro-electric projects supports this finding (Mainali & Silveira, 2011). The IWM-E technology is relatively new in Nepal, with only 4 IWM-E projects constructed. Consequently, framing relevant stakeholders as the IWM-E sector was troublesome. Given the lack of experience of stakeholders with IWM-Es, assessing qualities of IWM-E sector functions was difficult. Analysis of systemic problems in the IWM-E sector has, however, generated insights that can guide future credit facility. When further experience is built within the sector, analysis of the sector will potentially provide more insight into the functioning of the credit facility to IWM-Es.

4.3 Sustainability of alternative credit facility

This part of the analysis is based on quantitative data collected in 5 communities in rural Nepal combined with qualitative data on loan financing options. The alternative credit facility analysed in the second part emphasized the loan financing component. This third of the chapter incorporates all relevant sources for financing IWM-E upfront costs. It gives insight into the potential financial sustainability of the financial mix. The financial mix in this analysis consists of five components. These components are the community equity in kind, the community equity in cash, the loan component paid for by the community, the AEPC subsidy and the funding gap. Before the analysis per community is presented, the way the financial mix is calculated is explained. The analysis of financial mix per community gives an answer to the question:

To what extent can alternative structures of credit facility make credit facility for IWM-Es more sustainable?

The analysis uses data collected in the survey on the total willingness to pay for electricity incorporating a loan component. The average WTP per household is taken and then multiplied by the total number of households which are to be connected, or are connected, to electricity. The minimum cost of maintenance and operation is 120 NPR per month and this is subtracted from the WTP number (CRT-N). The WTP is a monthly tariff paid by the households for the service of electricity. This incorporates the loan repayment. The WTP minus 120 NPR is the WTP to pay for the loan monthly. To get insight into the willingness to invest (WTI), the contribution of community equity in cash (WTI) is used. It was asked how much NPR households were willing to invest in the IWM-E besides paying the monthly tariff. The average WTI per household is taken and multiplied by the total number of households which are to be connected, or are connected to electricity. The WTI is the cash households are ready to invest besides taking on a loan. This is an addition to the sum lent from the financial institutions paid for by the WTP. The community equity in kind is the average community equity provided for in the proof of the concept. This is an average of 20%. This community contribution consists of local materials and labor (CRT-N).

4.3.1 Loan options and requirements

Although the literature suggested that there was commercial micro financing, donor driven micro financing, informal micro financing and alternative micro financing, this analysis incorporates three options. The financial institutions observed in the field are Cooperatives, MFDBs, development banks and the donor driven CREF mechanism. Cooperatives and MFDBs were similar in their loan

requirements and are analyzed together as MFIs. The analysis, thus, incorporates three loan components. The variables in this loan component are loan duration in years and the interest rate. The three options are MFIs (Cooperatives and MFDBs in this part of the analysis), development banks and the CREF mechanism. CREF is argued to become operational in October, and thus, this option is also incorporated.

Table 2: Loan options and requirements

	MFIs	Development Banks	CREF
Interest annually	17%	12%	18%
Maximum Loan duration	2 years	5 years	7 years
Collatoral	Group collateral	Physical collateral	Group collatoral

The loan options and requirements presented in table 2 are the options observed in the field. The informal community lending option is excluded due a lack of data available for this option. Some stakeholders argued that this option was practiced, but no one could provide usable coherent data on interest rates, collateral requirements and loan durations. The study uses the average interest rate and maximum loan duration of MFIs and development banks observed in the interviews. For CREF, the stated interest rate and loan duration are used. In figure 3, the loan component consists of a MFI part, a development banks addition and a CREF addition. In all financial mixes, the CREF part was biggest and the MFI part was smallest. This is due to the significantly longer maximum loan duration, spreading repayment for the loan over a longer period increasing the size of the loan component. In order to present the whole financial mix in chart, the loan component is split up in these three parts. The MFI part represents the loan provision by MFIs in percentage of the total project costs. The MFI loan and the Development bank addition together (green and purple in figure 3) are the Development bank loan. The Development bank loan together with the CREF addition (green, purple and light blue in figure 3) make the CREF loan. In doing so, the aggregated components in the financial mix make up 100%. It also creates visual insight in the added value of choosing for a certain loan financing option.

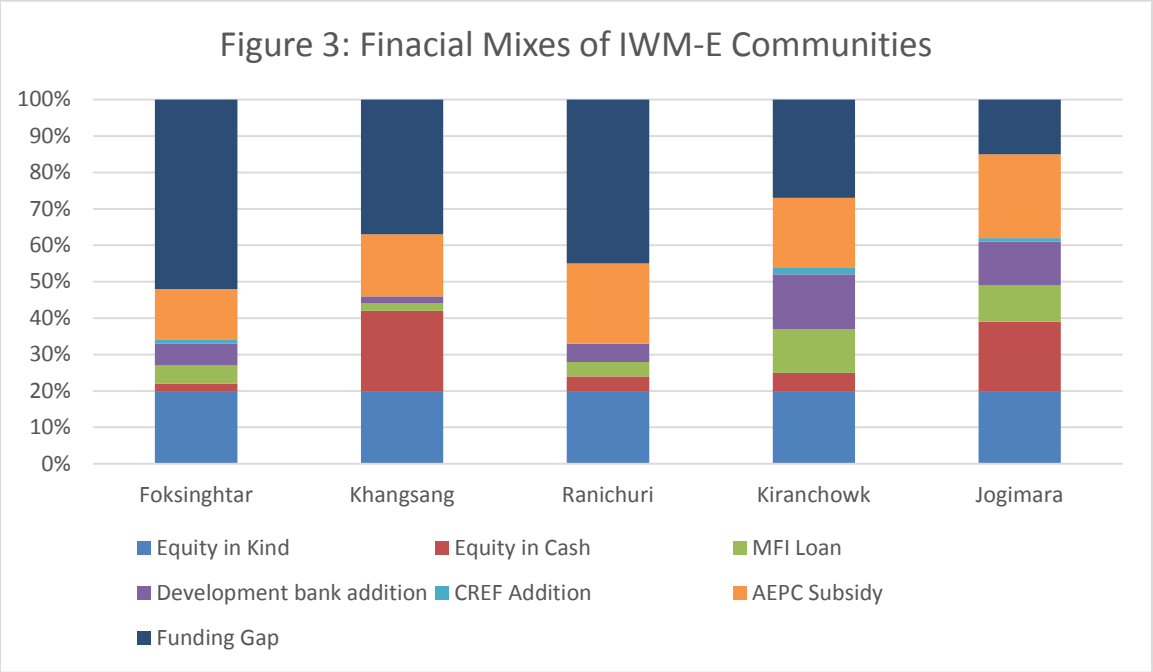
The AEPC subsidy consists of two components; the subsidy per HH and the subsidy per kW. All communities analyzed in this study are class C communities which means that they are relatively accessible. This means that there is a relatively small per HH subsidy of 6.000 NPR available. The per kW subsidy is 5.000 NPR. If all components are aggregated, the funding gap remains. This gap represents the necessary funding for completing the financial mix of the IWM-E project based on data collected in this study. The average cost of the IWM-E device in the proof of the concept is used as total upfront costs in this analysis and is 1,181,250 NPR (9,010.73 Euro) per IWM-E device. This gap is to be funded by either an increase in community contribution or an increase in external funding.

4.3.2 Hypothesis 9

Community contributions can make IWM-E financing more sustainable

Figure 3 presents the quantitative data collected in this study. The first relevant insight the quantitative data creates is that all communities incorporate a funding gap in the financial mix of the IWM-E upfront costs. The funding gap ranges between 15% Jogimara and 52% in Foksinghtar. Adding up equity in kind, equity in cash, the biggest potential loan contribution and the AEPC subsidy does not cover the upfront

costs for investing in IWM-Es in all 5 communities. The second insight that the data creates is that the subsidy provision ranges between 14% and 23%. The main determinant of this range is the number of households. The subsidy policy aims to provide 40% subsidy to renewable energy projects in Nepal (GON, 2013). The subsidy provision in these projects is significantly less than the stated 40%. The Foksinghtar, Khangsang, Ranichuri, Kiranchowk and Jogimara IWM-E communities consist of 26, 32, 40, 34, 42 households respectively. The third insight created by the data is the lack of added value in the loan size of the CREF loan option if CREF and the development bank option are compared. CREF creates an maximum added loan amount of 2% in Kiranchowk. Qualitative analysis, however, has demonstrated that physical collateral and distance from the financial institution form an obstacle for IWM-E communities. The development bank option is argued to be far from the IWM-E clients and requires physical collateral in the form of real estate. Therefore, the added loan size of the CREF is when compared to the MFI option better represents its added value for IWM-E communities. This ranges between 2% for Foksinghtar and 17% for Kiranchowk. Khangsang and Jogimara show the biggest equity in cash contributions. Jogimara, the community with the smallest funding gap has neither the biggest loan nor the biggest equity contribution but both these contributions are bigger than average community contributions in this study. The calculations and data behind figure 3 are added in Appendix C.



4.3.3 Sub-question 3

To what extent can alternative structures of credit facility make credit facility for IWM-Es more sustainable?

The data shows that both equity in cash and loan contributions of IWM-E communities can make the financial mix of IWM-Es less subsidy driven and more sustainable. The IWM-E communities researched,

however, contribute to IWM-E financing in different ways. The financial mix in all 5 communities leaves a funding gap which is to be filled in by external parties if the IWM-E devices are to be realized. The literature on financing hydro-electric projects argues that there are multiple trends visible in this financing. It is argued that subsidies investments become relatively less important, equity investments become relatively more important and investments financed by loans become relatively less important (Mainali & Silveira, 2011). Since this research collects data at one specific time and does not capture a time period, it is hard analyze if the data collected is in line with this. However, the data collected in this research shows clear equity and loan contributions. It is important to take into account the small sample size in the data collection. Influence of outliers on the data presented is significant and influences the outcomes of the analysis.

Chapter 5 - Conclusion

This research project's objective is to analyze the challenges and possible solutions for providing credit facility to IWM-E projects. The research has realized this objective by answering the following question:

> ***To what extent can current and alternative financial mechanisms provide sustainable credit facility to IWM-E projects?***

The 80% subsidy component in the current credit facility to IWM-E projects is not sustainable. It is argued that spending this much subsidy on IWM-E projects is not effective. To reach a bigger part of the rural Nepalese population, the IWM-E projects need to depend on less subsidies and more on community contributions. This is in accordance with theory arguing that development work increasingly seeks incorporation of private sector investments in that the community contribution is argued to involve loan financing. Local involvement in development, financing and implementation of the projects is argued to be important in the literature. This involvement is present in the current IWM-E implementation. Due to a 20% equity contribution, IWM-E communities are involved in financing, implementing and developing the project, although the contribution to financing is argued to be too small.

Alternative sources of credit facility are present in the IWM-E sector. Credit Cooperatives, MFDBs and Development Banks are able to provide credit facility to IWM-E projects. Furthermore, the CREF mechanism is argued to be able to provide credit facility to IWM-Es in October 2014. The lack of experience of stakeholders with IWM-Es, the small number of IWM-Es implemented and the inexperience in providing credit facility to IWM-Es in Nepal has made assessment of the quality of IWM-E sector functions difficult. Due to this lack of experience, connections of systemic problems with specific loan financing options could not be established and more general systemic problems in credit facility to IWM-Es are analyzed. The lack of experience has also caused stakeholders to interpret and perceive problems differently. Finding consensus on topics was difficult due to this. The analysis has, therefore, created insight into a wide range of challenges that need to be addressed in providing credit facility to IWM-E communities.

In analyzing the quality of the IWM-E sector functions, the functioning of the entrepreneurial activities of the financial institutions is argued to be adequate. Their presence near IWM-E communities and their provision of physical-collateral-free loans is important. The second and third functions, knowledge development and guidance of search for IWM-E credit facility, are argued to be sufficient and this has resulted in the incorporation of IWM-E financing in the CREF mechanism. It is argued that this mechanism tackles the cumbersome subsidy provision which is a challenge in IWM-E credit facility. It is also argued that the CREF mechanism will focus on building capacity within IWM-E communities and financial institutions involved in providing financial services to these communities. With regards to the fourth function, this targets problems of mobilizing capacity building and subsidy provision resources. The CREF mechanism is still a theoretical mechanism. It needs to prove the intended services it is argued

to provide to IWM-E communities. It is unclear to what extent end-user factors local knowledge, trust, and flexibility in providing credit facility are incorporated in the mechanism.

The fifth function, dissemination of knowledge on IWM-E credit facility is argued to be insufficient and most financial institutions don't know the IWM-E technology. Involvement of financial institutions and knowledge institutes in developing and disseminating knowledge on credit facility needs to be sought. There are problems in the sixth function, market formation, due to projects being subsidy driven. Site selection criteria of financial institutions and implementers are contradicting and this is argued to hinder the growth of the IWM-E market. A form of risk sharing between investors and other parties is argued to be important in making IWM-E investments more legitimate for financial institutions which targets problems in the IWM-E sector function of creating legitimacy for investing in the technology.

The utilization of the options for loan financing found in qualitative analysis, combined with community equity investments in kind and in cash and a AEPC government subsidy, still leaves a funding gap in all 5 communities researched in this study. The community contributions in equity in cash and a loan component calculated from WTP and WTI data can be significant. This community contribution can make the financial mix of IWM-E projects more sustainable when compared to the current financial mix. The CREF option is, although still theoretical, the recommended option as it suits IWM-E community requirements of no physical collateral and relatively long loan durations. Due to the small sample size, generalizations based on the data cannot be made and influence of outliers in the data, on the analysis, is big. It is argued in literature that subsidy investments become relatively less important, equity investments become relatively more important and investments financed by loans become relatively less important in financing hydro-electric projects in rural Nepal. The insights created in this study, however, do not support this theory and the data shows no clear bigger relative importance of equity investments in cash. The stated objective of providing 40% subsidy to rural off-grid renewable energy technologies is not reached for IWM-Es receive a maximum of 23% subsidy in the communities researched. The potential community contributions, combined with an incorporation of solutions to systemic problems can make credit facility more sustainable when compared to the current credit facility model. Government subsidies and donor driven credit facility are, however, necessary to enable IWM-E communities to finance the IWM-E technology.

Policy recommendations

To enable a more sustainable credit facility to IWM-E projects, this research recommends to take the following measures:

- Incorporate an analysis of the potential financial community contributions in the site selection by analyzing the potential community equity in cash and loan financing contributions. Special attention needs to be given to the cost of this analysis subtracted from added value it creates.
- Create a platform for sharing knowledge in the IWM-E sector to enable efficient knowledge dissemination.
- Incorporate micro finance institutions in the development of a credit facility mechanism to incorporate practical knowledge in the mechanism. Give special attention to a risk sharing component in the credit facility mechanism to make investments more legitimate.
- Conduct a contingent valuation study with bigger samples that enable generalization in order to get better insight in the potential community contributions in financing IWM-Es. Insight in the variables which enable a bigger community contribution can be beneficial for sustainably financing IWM-E projects.
- Analyze systemic problems for financing IWM-Es once more experience with implementing IWM-E projects is built within the IWM-E sector. Make participants in this study rank the problems to enable insight in the relative importance of different systemic problems.
- Conduct a cost-benefit analysis for the IWM-E technology and compare the costs and benefits with competing technologies such as solar home systems or small windmills.
- Research the potential of fee-for-service financing since this targets upfront costs. In studying this, special attention to the consequences of this financing mechanism for the sense of ownership of the community has to be given.

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Appendix A - Interviewees

S.No.	Name	Location	Organization	Function in Organization
1.	Mahesh Neupane	Kiranchowk VDC, Dhading	V.D.C Kiranchowk	Office Assistant
2.	Sanjay Tamang	Kiranchowk VDC, Dhading	IWM-E Committee	Owner + Chairperson
3.	Biplav Kafle		CRT-N	Technical Lead in IWM-E
4.	Sher Bahadur Bhandari	Kiranchowk VDC, Dhading	LPO	
5.	Rabi Aale & Kalyan Adhikari	Kiranchowk VDC, Dhading	Shree Kiranchowk Agriculture Cooperative Organization	Administration
6.	Bhagwati Aryal	Dhadingbesi, Dhading	Neelkantha Women Savings & Loan Cooperative	Chairperson
7.	Parshuram Ghimire	Dhadingbesi, Dhading	V.D.C. Jogimara	Non-Gazette Officer
8.	Govinda Bahadur Bhandari	Dhadingbesi, Dhading	GOA Dhading	District Chairperson
9.	Rishi Lal Chepang	Robang, Jogimara	Tilingtar Ghatta Electrification	Committee Chairperson
10.	Naresh Nepal	Lazimpat, Kathmandu	Center for Micro-Finance (CMF)	Deputy CEO
11.	Padam Bahadur Ghising	Foksingtar -2, Kavre	Fedi Khola IWM-E Project	Owner + Chairperson
12.	Pinaki Raj Dahal	Sindhulimadi, Sindhuli	Matribhumi Development Bank	Chief Officer
13.	Ramakant Subedi	Sindhulimadi, Sindhuli	Country Development Bank	Branch Manager
14.	Narayan Adhikari	Sindhulimadi, Sindhuli	D.D.C. Sindhuli	Office Assistant
15.	Loknath Mishra	Sindhulimadi, Sindhuli	Chimek MFI Bank	Branch Manager
16.	Lal Bahadur Shrestha	Sindhulimadi, Sindhuli	GOA Sindhuli	Chairperson
17.	Tek Nath Pahadi	Khangsang -1 VDC, Sindhuli	IWM-E	Owner
18.	Dinesh Dulal	Sitapaila, Kathmandu	Clean Energy	Project Manager

			Development Bank Ltd. (CEDB)	
19.	Rajesh Bhattarai	Thamel, Kathmandu	Himalayan Bank Pvt. Ltd	Relationship Manager
20.	Manu Binod Aryal	Khumaltar, Kathmandu	AEPC	Capacity Building Specialist
21.	Narayan Prasad Poudel	Baluwatar, Kathmandu	Micro-Finance & Supervision Department, Nepal Rastra Bank (NRB)	Director
22.	Samir Thapa	Khumaltar, Kathmandu	Bio-Gas Sub Component, AEPC	Assistant Director
23.	Nim Bahadur Magar	Ranichure, Sindhuli	IWME-Committee	President
24.	Bart Jan van Beuzekom	Kathmandu	GIZ-EnDev	Chief technical advisor

Appendix B – Topic list

Current Model

- Current 80/20 model
- Sustainability

If no experience with loan financing

- Potential financiers
- Capacity to handle and get a loan
- Willingness to get a loan

General loan questions

- Getting a loan and loan eligibility
- Role of 3/5% obligated developmental finance
- Gap between conventional and MFDBs/Coops

Alternatives

- Know about alternatives
- How they target costs
- Importance of donor driven subsidy in alternative models

    Specific

    - Direct
    - Cluster based
    - Vendor financing
    - Financing through MFI to individuals
    - Financing through MFI to groups
    - Other alternatives

Capacity

- Influence of capacity on getting a loan
- Training for capacity
- Community or individual ownership

Community specific

- Cash flow of IWM-E
- Willingness to take up a loan
- Managerial IWM-E manager issues

Challenges

- Community feature obstacles
- Other obstacles

Seven functions of IWM-E sector

- entrepreneurial activities
- knowledge development,
- Knowledge diffusion
- guidance of search
- market formation
- mobilization of resources
- creation of legitimacy

Cost

- Costs in providing loan
    - Distance
    - Administrative
    - Regulation
    - Capacity
    - Other?
- Interest rates
- Loan durations
- Default rates
- collateral

Appendix C - Calculations

Community 1: Foksinghtar

No. of HH = 26

Willingness To Pay (average) = 231.43

Willingness To Pay – Tariff Set = 231.43 – 120 = **Rs. 111.43**

Willingness To Pay for 26 HH = 111.43 * 26 = Rs. 2,897.18 / month

= Rs. 34,766.16 / year

Equity / HH = Rs. 1,142.86 ; **Equity for 26HH = Rs. 29,714.36**

1. **MFI** ;
   i = 17% (loan avg between 16-18%), t = 2 years (max. avg)
   Loan Amount per HH = Rs. 2,254
   Loan Amount for 26 HH = Rs. 2,254 * 26 = Rs. 58,604
2. **CREF** ;
   i = 18%, t = 7 years
   Loan Amount per HH = Rs. 5,302
   Loan Amount for 26 HH = Rs. 5,302 * 26 = Rs. 1,37,852
3. **Development Banks** ;
   I = 12 %, t = 5 years
   Loan Amount per HH = Rs. 5,010
   Loan Amount for 26 HH = Rs. 5,010 * 26 = Rs. 1,30,260

AEPC Subsidy

Subsidy (per HH) = 26 * 6000 = 1,56,000

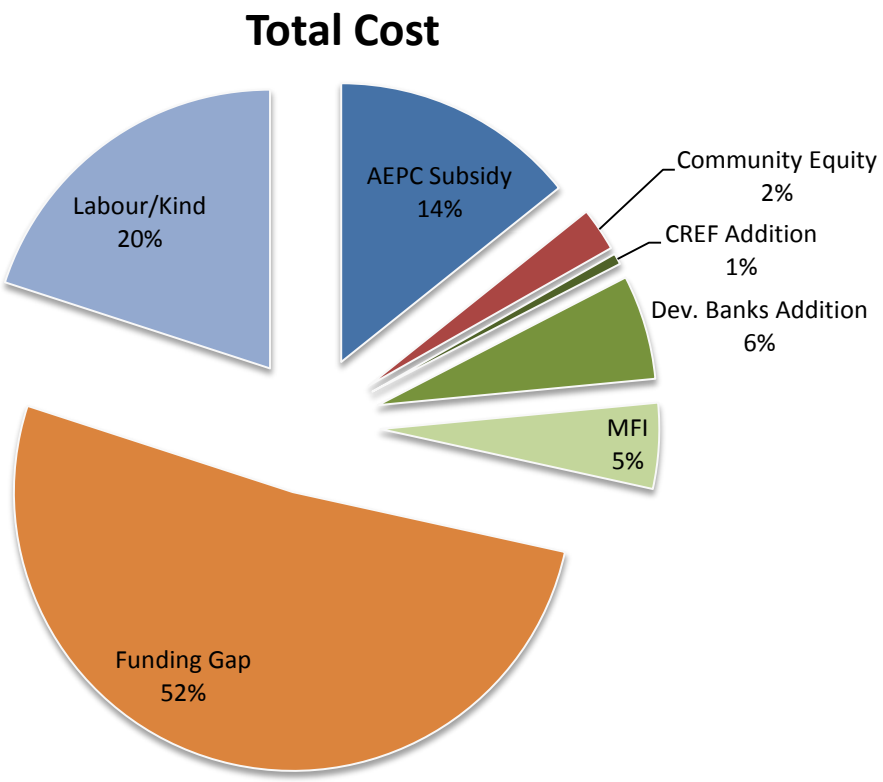
Transportation Subsidy (per kW) = 2.5 * 5000 = 12,5000

Total AEPC Subsidy = 1,56,000 + 12,500 = 1,68,500

Name of Site	District	No. of HH	Willingness To Pay(average)	Willingness To Pay - Tariff Set	Willingness To Pay - tarriff * No. of HH per month
Foksingtar	Kavre	26	231.43	231.43-120= 111.43	2,897.18

Loan Component	Interest Rate	Loan Duration	Loan Amount per HH	Loan Amount for Total HH
MFI	17%	2	2,254	58,604
CREF	18%	7	5,302	1,37,852
Development Banks	12%	5	5,010	1,30,260

AEPC Subsidy	No. of HH	Subsidy	Transportation Subsidy	Total AEPC Subsidy
	26	1,56,000	12,500	1,68,500



	Total amount (NPR)
AEPC Subsidy	168,500
Community Equity	29,714.36
CREF Addition	7,592.00
Dev. Banks Addition	71,656.00
MFI	58,604
Funding Gap	608,933.64
Labour/Kind	236,250
	11,81,250

Community 2: Khangsang

No. of HH = 32

Willingness To Pay (average) = 148.57

Willingness To Pay – Tariff Set = 148.57 – 120 = **Rs. 28.57**

Willingness To Pay for 22 HH = 28.57 * 32 = Rs. 914.24 / month

= Rs. 10,970.88 / year

Equity / HH = Rs. 8,000 ; **Equity for 32HH = Rs. 2,56,000**

1. **MFI** ;
   i = 17% (loan avg between 16-18%), t = 2 years (max. avg)
   Loan Amount per HH = Rs. 578
   Loan Amount for 32 HH = Rs. 578 * 32 = Rs. 18,496

2. **CREF** ;
   i = 18%, t = 7 years
   Loan Amount per HH = Rs. 1,360
   Loan Amount for 32 HH = Rs. 1,360 * 32 = Rs. 43,520
3. **Development Banks** ;
   i = 12 %, t = 5 years
   Loan Amount per HH = Rs. 1,285
   Loan Amount for 32 HH = Rs. 1,285 * 32 = Rs. 41,120

AEPC Subsidy

Subsidy (per HH) = 32 * 6000 = 1,92,000

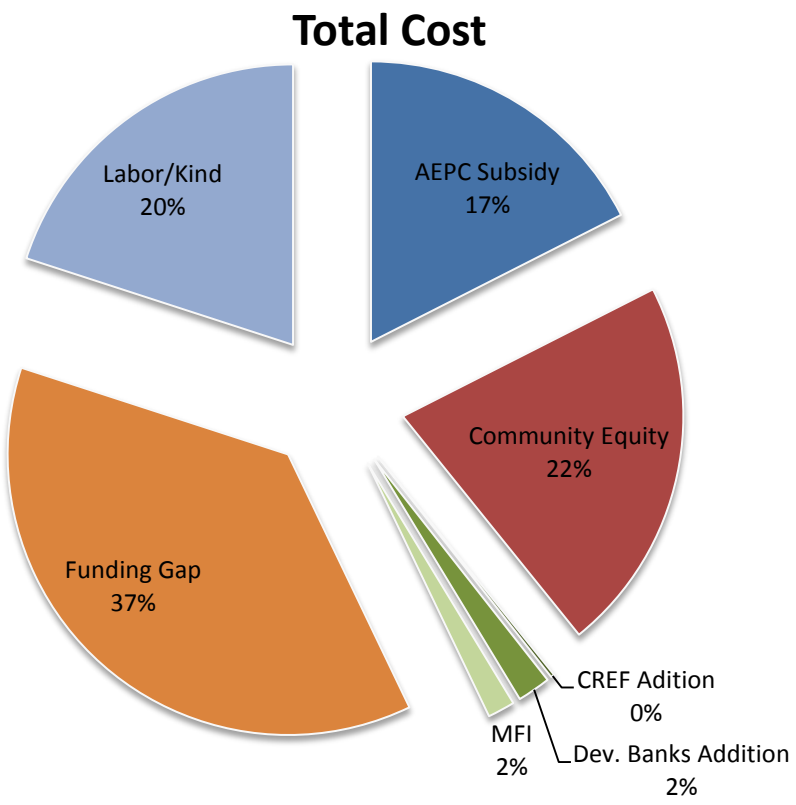
Transportation Subsidy (per kW) = 3 * 5000 = 15,000

Total AEPC Subsidy = 1,92,000 + 15,000 = 2,07,000

Name of Site	District	No. of HH	Willingness To Pay(average)	Willingness To Pay - Tariff Set	Willingness To Pay - tariff * No. of HH per month
Khangsang	Sindhuli	32	148.57	148.57-120=28.57	914.24

Loan Component	Interest Rate	Loan Duration	Loan Amount per HH	Loan Amount for Total HH
MFI	17%	2	578	18,496
CREF	18%	7	1,360	43,520
Development Banks	12%	5	1,285	41,120

AEPC Subsidy	No. of HH	Subsidy	Transportation Subsidy	Total AEPC Subsidy
	32	1,92,000	15,000	2,07,000



	Total amount (NPR)
AEPC Subsidy	2,07,000
Community Equity	2,56,000
CREF Adition	2,400
Dev. Banks Addition	22,624
MFI	18,496
Funding Gap	4,38,480
Labor/Kind	2,36,250
	11,81,250

Community 3: Ranichuri

No. of HH = 40
Willingness To Pay (average) = 174.29
Willingness To Pay – Tariff Set = 174.29 – 120 = **Rs. 54.29**
Willingness To Pay for 40 HH = 54.29 * 40 = Rs. 2,171.6 / month
= Rs. 26,059.2 / year
Equity / HH = Rs. 1,285.71 ; **Equity for 40 HH = Rs. 51,428.4**

1. **MFI** ;
   i = 17% (loan avg between 16-18%), t = 2 years (max. avg)
   Loan Amount per HH = Rs. 1,098
   Loan Amount for 40 HH = Rs. 1,098 * 40 = Rs. 43,920
2. **CREF** ;
   i = 18%, t = 7 years
   Loan Amount per HH = Rs. 2,583
   Loan Amount for 40 HH = Rs. 2,583 * 40 = Rs. 1,03,320
3. **Development Banks** ;
   i = 12 %, t = 5 years
   Loan Amount per HH = Rs. 2,440
   Loan Amount for 40 HH = Rs. 2,440 * 40 = Rs. 97,600

AEPC Subsidy

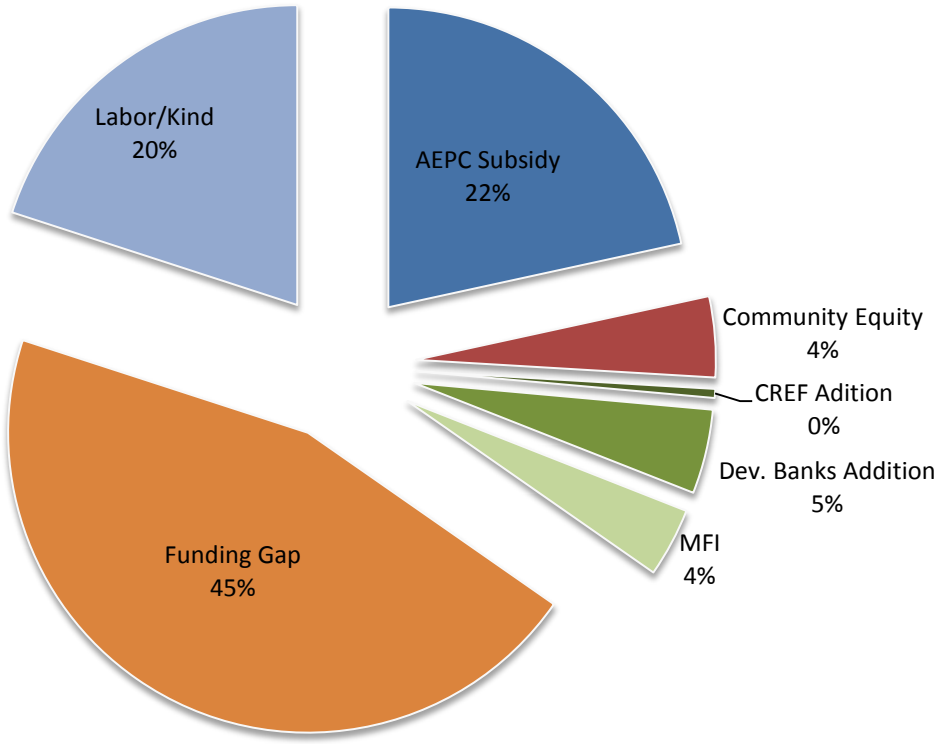
Subsidy (per HH) = 40 * 6000 = 2,40,000
Transportation Subsidy (per kW) = 3 * 5000 = 15,000
Total AEPC Subsidy = 2,40,000 + 15,000 = 2,55,000

Name of Site	District	No. of HH	Willingness To Pay(average)	Willingness To Pay - Tariff Set	Willingness To Pay - tariff * No. of HH per month
Ranichuri	Sindhuli	40	174.29	174.29-120= 54.29	2,171.6

Loan Component	Interest Rate	Loan Duration	Loan Amount per HH	Loan Amount for Total HH
MFI	17%	2	1,098	43,920
CREF	18%	7	2,583	1,03,320
Development Banks	12%	5	2,440	97,600

AEPC Subsidy	No. of HH	Subsidy	Transportation Subsidy	Total AEPC Subsidy
	40	2,40,000	15,000	2,55,000

Total Cost



	Total amount (NPR)
AEPC Subsidy	2,55,000
Community Equity	51,428.4
CREF Adition	5,720
Dev. Banks Addition	53,680
MFI	43,920
Funding Gap	5,35,251.6
Labor/Kind	2,36,250
	11,81,250

Community 4: Kiranchowk

No. of HH = 34
Willingness To Pay (average) = 331.4
Willingness To Pay – Tariff Set = 331.4 – 120 = **Rs. 211.4**
Willingness To Pay for 32 HH = 211.4 * 34 = Rs.7,187.6 / month
= Rs. 86,251.2 / year
Equity / HH = Rs. 1,714.29 ; **Equity for 34HH = Rs. 58,285.86**

4. **MFI** ;
   i = 17% (loan avg between 16-18%), t = 2 years (max. avg)
   Loan Amount per HH = Rs. 4,276
   Loan Amount for 34 HH = Rs. 4,276 * 34 = Rs. 1,45,384
5. **CREF** ;
   i = 18%, t = 7 years
   Loan Amount per HH = Rs. 10,058
   Loan Amount for 34 HH = Rs. 10,058 * 34 = Rs. 3,41,972
6. **Development Banks** ;
   I = 12 %, t = 5 years
   Loan Amount per HH = Rs. 9,505
   Loan Amount for 34 HH = Rs. 9,505 * 34 = Rs. 3,23,170

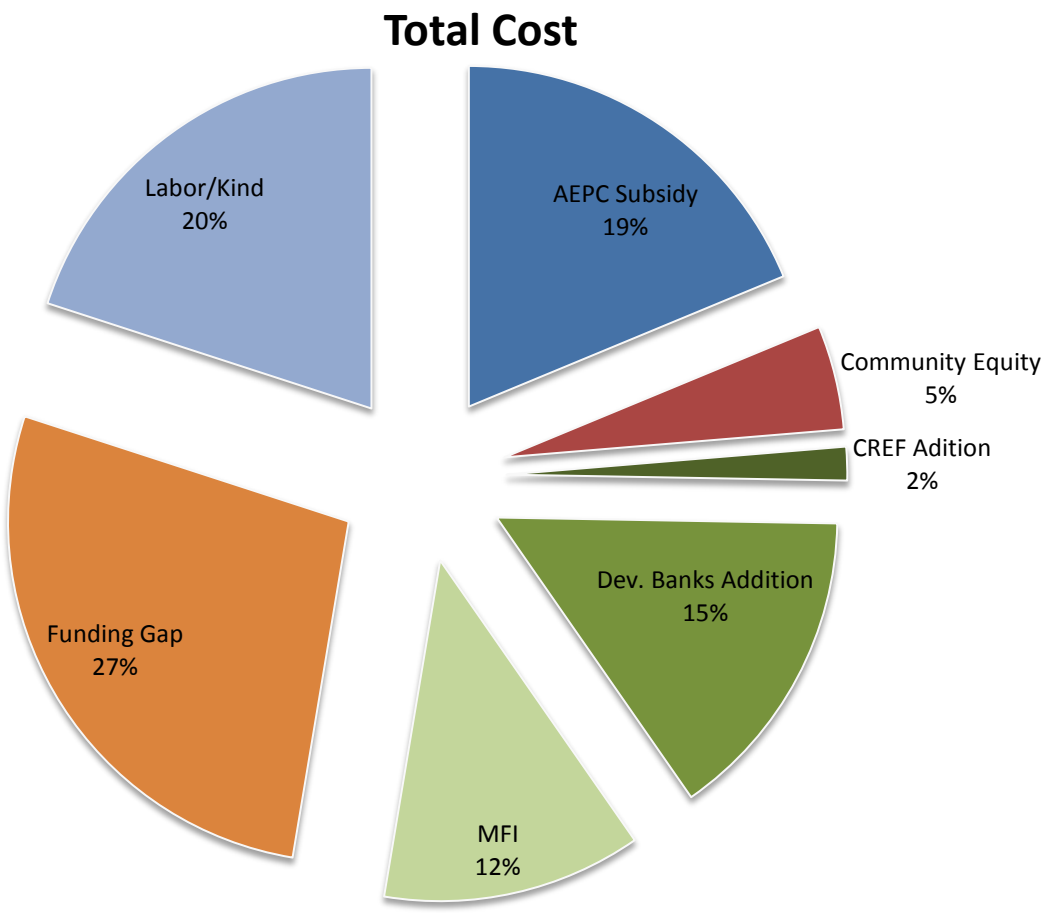
AEPC Subsidy

Subsidy (per HH) = 34 * 6000 = 2,04,000
Transportation Subsidy (per kW) = 3.5 * 5000 = 17,500
Total AEPC Subsidy = 2,04,000 + 17,500 = 2,21,500

Name of Site	District	No. of HH	Willingness To Pay(average)	Willingness To Pay - Tariff Set	Willingness To Pay - tariff * No. of HH per month
Kiranchowk	Dhading	34	331.4	331.4 - 120 = 211.4	7,187.6

Loan Component	Interest Rate	Loan Duration	Loan Amount per HH	Loan Amount for Total HH
MFI	17%	2	4,276	1,45,384
CREF	18%	7	10,058	3,41,972
Development Banks	12%	5	9,505	3,23,170

AEPC Subsidy	No. of HH	Subsidy	Transportation Subsidy	Total AEPC Subsidy
	34	2,04,000	17,500	2,21,500



	Total amount (NPR)
AEPC Subsidy	2,21,500
Community Equity	58,285.86
CREF Adition	18,802
Dev. Banks Addition	1,77,786
MFI	1,45,384
Funding Gap	3,23,242.14
Labor/Kind	2,36,250
	11,81,250

Community 5: Jogimara

No. of HH = 42

Willingness To Pay (average) = 253.33

Willingness To Pay – Tariff Set = 253.33 – 120 = **Rs. 133.33**

Willingness To Pay for 42 HH = 133.33 * 42 = Rs.5,599.86 / month

= Rs. 67,198.32 / year

Equity / HH = Rs. 5,500 ; **Equity for 42HH = Rs. 2,31,000**

7. **MFI** ;
   i = 17% (loan avg between 16-18%), t = 2 years (max. avg)
   Loan Amount per HH = Rs. 2,696
   Loan Amount for 42 HH = Rs. 2,696 * 42 = Rs. 1,13,232
8. **CREF** ;
   i = 18%, t = 7 years
   Loan Amount per HH = Rs. 6,342
   Loan Amount for 42 HH = Rs. 6,342 * 42 = Rs. 2,66,364
9. **Development Banks** ;
   I = 12 %, t = 5 years
   Loan Amount per HH = Rs. 5,994
   Loan Amount for 42 HH = Rs. 5,994 * 42 = Rs. 2,51,748

AEPC Subsidy

Subsidy (per HH) = 42 * 6000 = 2,52,000

Transportation Subsidy (per kW) = 3 * 5000 = 15,000

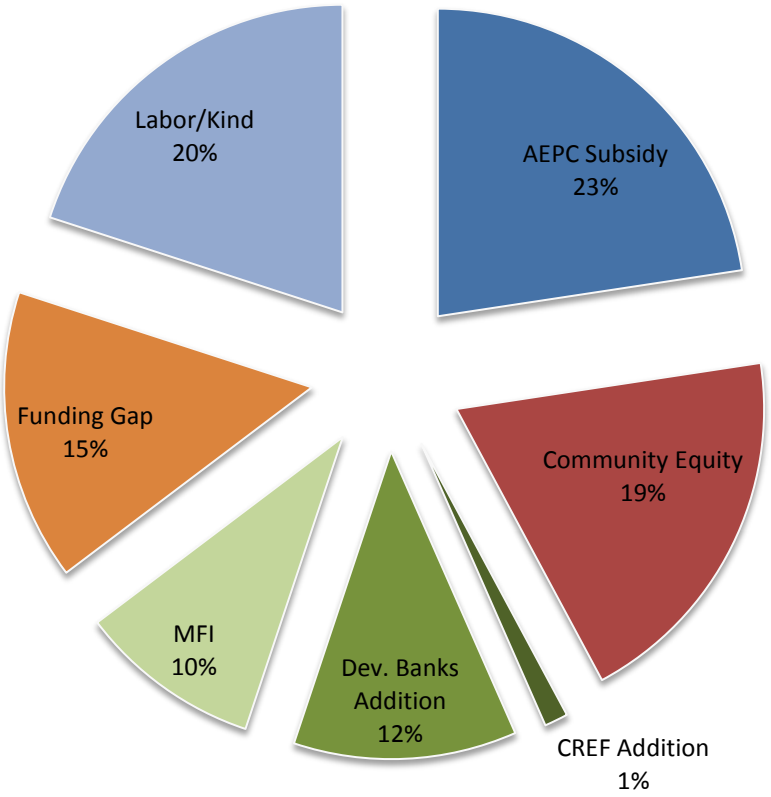
Total AEPC Subsidy = 2,52,000 + 15,000 = 2,67,000

Name of Site	District	No. of HH	Willingness To Pay(average)	Willingness To Pay - Tariff Set	Willingness To Pay - tariff * No. of HH per month
Jogimara	Dhading	42	253.33	253.33-120 = 133.33	5,599.86

Loan Component	Interest Rate	Loan Duration	Loan Amount per HH	Loan Amount for Total HH
MFI	17%	2	2,696	1,13,232
CREF	18%	7	6,342	2,66,364
Development Banks	12%	5	5,994	2,51,748

AEPC Subsidy	No. of HH	Subsidy	Transportation Subsidy	Total AEPC Subsidy
	42	2,52,000	15,000	2,67,000

Total Cost



	Total amount (NPR)
AEPC Subsidy	2,67,000
Community Equity	2,31,000
CREF Adition	14,616
Dev. Banks Addition	1,38,516
MFI	1,13,232
Funding Gap	1,80,636
Labor/Kind	2,36,250
	11,81,250